

AFIT/GCA/LAS/97S-8

**A STUDY OF HISTORICAL INFLATION
FORECASTS USED IN THE DEPARTMENT OF
DEFENSE FUTURE YEARS DEFENSE PROGRAM**

THESIS

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DEPARTMENT OF DEFENSE FUTURE YEARS DEFENSE PROGRAM

THESIS

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Abstract

This thesis explores historical inflation forecasts used in the Department of Defense (DoD) Future Years Defense Program. Recent General Accounting Office reports assert DoD inflation forecasts mandated by the Office of Management and Budget (OMB) are optimistic and exhibit a downward bias. This study tests this assertion by examining historical DoD forecasts against experienced inflation as measured by the Gross Domestic Product and Gross National Product implicit price deflator (GNP/GDP IPD) from 1979 to 1996. This study also compares the accuracy of DoD forecasts with those made by the Congressional Budget Office (CBO) and Data Resources, Incorporated (DRI). The results regarding the performance of historical DoD inflation forecasts are mixed. Upon examining budget through five year GNP/GDP IPD forecast spans, DoD short-term results do not indicate a downward bias and DoD long-term results do indicate a slight downward bias. Overall DoD forecast bias was lower than the CBO and DRI which tended to overestimate inflation. Next, forecast accuracy was evaluated in which all agencies equally anticipated budget year inflation. Forecasts for later years also yielded mixed results. CBO and DRI forecasts tend to exhibit less dispersion, but DoD tends to have less bias. DRI one, two, and three year forecasts and CBO four and five year projections demonstrated the least dispersion while DoD forecast results were more dispersed. Possible explanations and implications of these findings are provided.

A STUDY OF HISTORICAL INFLATION FORECASTS USED IN THE DEPARTMENT OF DEFENSE FUTURE YEARS DEFENSE PROGRAM

I. Problem Description

Introduction

Inflation rate projections are important tools used by cost analysts to forecast future Department of Defense (DoD) funding requirements and expenditures on acquisition programs that can last as long as twenty years from concept to a fielded system, and may then be in the operational inventory for thirty or more years. The various methodologies used by government and private sector agencies to forecast inflation, generally regarded to be based on well-established econometric principles, lead to a variety of inflation estimates. Accurate and reliable estimates of future inflation are important to the DoD. Accurate and reliable estimates allow proper expression of life cycle costs, budgeting and program requirements, and trades among competing alternatives. In January of every year, an updated DoD Future Years Defense Program (FYDP) is published based in part on adjustments due to program changes, Congressional changes, and adjustments to the anticipated inflation rate for military and civilian pay, fuel, and other expenditure categories. In 1997, the General Accounting Office (GAO) cited the DoD as reporting a \$34.7 billion dollar difference in the 1996 FYDP to 1997

FYDP based on a 6/10th of one percent change in anticipated inflation, which was the most significant adjustment. Congressional estimates were lower with an estimate of a \$10.3 billion dollar change over the same time period (GAO, 1997:6). This demonstrates significant sensitivity in anticipated defense costs based on differences between DoD and Congressional inflation forecasts. This thesis will explore whether historical evidence supports the GAO assertion that "Department of Defense employs a systematic bias toward overly optimistic planning assumptions" (1994:3) which implies FYDP inflation rate forecasts have a downward bias and are overly optimistic. The research can also be used to determine which forecast agencies have historically been most accurate in view of the experienced inflation rate.

Background

Over the last decade, the DoD has enjoyed relatively low inflation which has lowered the net inflationary impact on long term defense related programs and acquisitions. However, over-estimates and under-estimates of inflation in the past have respectively created over and under budgeted military defense programs. A press release by the Office of the Secretary of Defense (OSD) entitled *Department of Defense Budget for FY 1998* stated, "...President Clinton, during the final weeks of budget preparation, added \$7 billion to the DoD topline and allowed DoD to keep \$4 billion of inflation savings" (Jack, 1997:1). Even small adjustments to inflation forecasts have a tremendous influence on military budgets. In the 1997 constant-year \$266 billion dollar defense

budget, a one percent adjustment represents \$2.66 billion dollars and a 0.1 percent inflation adjustment represents \$266 million dollars (OMB, 1997).

The FYDP utilizes OMB mandated inflation rates to predict future program expenditures. However the actual authorization is provided by Congress which is constitutionally empowered to appropriate funds expended on military programs. Congress evaluates the FYDP annually through budget and defense sub-committee hearings using separate forecasts, supplied by the Congressional Budget Office (CBO), rather than the Administration's estimate of anticipated inflation. Differences between DoD and CBO inflation estimates are debated and military leaders are routinely called to testify. In February, 1997, the GAO reported a \$24.4 billion difference in the 1997 FYDP based on the variation between CBO and DoD inflation estimates (GAO, 1997). This difference is generally accepted as reasonable and justifiable due the uncertainty of predicting future inflation. However, adjustments to inflation estimates are sensitive since minor differences may represent billions of dollars in future funding requirements. Further, the Administration and Congress have no obligation to compensate the DoD for unexpected changes in future inflation. According to OMB Circular A-11, program cost estimates must include allowances for inflation and, "unless the OMB determines otherwise, agency requests are expected to be within their budget planning guidance, regardless of inflation" (OMB, 1996:1). The potential problem with this policy when the Defense Budget is presented to Congress is that there is no special consideration for higher than anticipated inflation on military programs, except for military pay and fuel rates. Long-term military programs that experience higher than anticipated inflation after

monetary budgets are appropriated invariably run the risk of cost over-runs. For example, the F-16 development estimate in fiscal year 1975 was \$6.05 billion which included anticipated inflation of \$1.68 billion (5.2%) through 1986. By 1981, schedule delays, design changes, and other program alterations required an additional \$6.71 billion, resulting in Congressional criticism of the entire program. One component of this total, unanticipated inflation, is the topic of this research effort. Some \$3.78 billion was required to fund unanticipated inflation experienced between 1976 and 1981 (Congress, 1981:23). In this example, 56% of F-16 cost over-runs were the result of defense planners underestimating future inflation. Thus, improved military estimates of future inflation will help reduce future cost over-runs in military programs. Ideally, military programs with unbiased inflation estimates possess an equal likelihood of experiencing cost under-runs due to lower than anticipated inflation or of experiencing cost over-runs due to higher than anticipated inflation.

In a memorandum sent to the Heads of Executive Departments and Establishments, which includes the DoD, the Director of the OMB stated, "Future inflation is highly uncertain. Analysts should avoid having to make an assumption about the general rate of inflation whenever possible" (Darman, 1992:7). Given that changes to inflation forecasts are often the most significant adjustment affecting the yearly defense budget, inflation stands out as a significant cost driver, which due to both its significant size and volatility from year to year, should not be ignored by cost analysts (GAO, 1997). Due to the fact the CBO and OMB depend on different inflation forecast methodologies to evaluate future defense expenditures, both have been criticized in the past for

producing forecasts that are politically self serving, rather than being objective attempts to accurately project future inflation rates. The pressure to downsize the military, lower budgets, and stretch-out programs may encourage overly optimistic DoD estimates that eventually could lead to budgetary shortfalls, lower procurement numbers, and reduced military capability. This potential problem underscores the importance of reliable inflation rate forecasts. To better understand the various acronyms and terms used in this thesis, descriptions are found in Appendix B, Glossary of Acronyms & Terms.

Purpose of the Study

Air Force cost analysts rely on inflation forecasts and projections provided by the Secretary of the Air Force Directorate of Economics and Business Management (SAF/FMCE) which uses figures mandated by the Office of the Secretary of Defense (Comptroller) (OSD(C)). This thesis attempts to assist Air Force cost analysts by evaluating the accuracy of inflation estimates used in the Future Years Defense Program (FYDP). Inflation forecasts possess a range of variability due to the uncertainty of predicting future inflation. As planned FYDP defense programs cycle from six to one year away from the budget year, the anticipated inflation rate is continually revised. Recent GAO reports have indicated DoD forecasts have a downward bias (GAO, 1997, 1994) which would, if true, result in under funding requirements. This research evaluated historical inflation forecasts used to develop the FYDP against the experienced inflation rate to determine if a downward bias can be discerned from the historical data. The results attempt to determine if DoD is using valid and unbiased inflation forecasts.

This thesis also attempts to evaluate differences between FYDP inflation estimates developed within its six-year time period and compare these results with other forecasting agencies to determine which provide more reliable inflation projections.

Statement of Problem

The measurement and projection of inflation in the DoD and its impact on the procurement of weapon systems have become increasingly important as defense spending decreases, weapon systems undergo long delays and stretch outs, and political pressure builds to balance the federal budget. Congress reported “the direct effects of underestimated inflation on the DoD are higher program costs, higher per unit costs, fewer weapons purchased, and lengthened time until the system is operational” (1981:11). The potential problems associated with underestimating inflation remain an item of concern to the DoD since GAO reports suggest DoD inflation forecasts may be on the average low and optimistic (GAO, 1994:1). Do inflation forecasts currently used by the DoD have a downward bias? This retrospective analysis also attempts to determine which forecast agencies are most accurate in view of the experienced inflation rate from 1979 to 1996. The null hypothesis is that DoD inflation rate forecasts have no bias. This thesis will attempt to answer the following questions:

1. Do historical FYDP inflation forecasts, as measured by the GDP IPD, demonstrate consistent variance compared to actual inflation as the forecast time increases from the budget year to the five year span? (Are short and long term forecasts equally accurate?)

2. Do historical DoD inflation rates, as measured by the GDP IPD, exhibit a downward bias when compared to the experienced rate?
3. Which GNP/GDP IPD forecasting agencies are consistently more accurate when viewed retrospectively in view of experienced inflation?

Scope of the Study

This research compares historical GNP/GDP IPD rates as mandated by the OMB to the Department of Defense (DoD) from 1979 to 1996 with actual inflation rates; as well as with historical forecasts of the following organizations: Congressional Budget Office and Data Resources, Incorporated (DRI). A naïve approach which involves no special esoteric knowledge of inflation or in-depth statistical techniques is used as a measurement baseline. For visual comparison, past inflation projections and the actual inflation rate were graphed over time. Each forecasting technique was evaluated for bias using the non-parametric sign test; and accuracy, using standard statistical measurements including variance, mean error, mean absolute deviation (MAD), and the root mean square error (RMSE).

Outline of Remainder of Thesis

This thesis is organized in a traditional format. This chapter introduced the purpose of the study, the scope of the problem and some necessary background. The next chapter briefly illustrates how this thesis fits into related research. The methodology, results, and conclusions are presented in subsequent chapters. In addition to this

discussion, appendices containing illustrative and supporting data are provided along with a comprehensive bibliography.

II. Literature Review

Introduction

Due to the sheer size of the Unified Federal Budget, the accuracy of adjustments for anticipated inflation has a large dollar impact on federal outlays such as defense expenditures. For the U.S. economy, price changes on specific items are traceable from year to year, but this change is also influenced by non-inflationary factors such as changes in consumer preference, market forces, and technological advancements. Economists must weigh the source of these changes to calculate the underlying inflation rate. While past inflation measurements are deemed reliable, Department of Defense (DoD) policy decisions and Congressional appropriations are based on estimates of future inflation which are subject to the variation previously described in Chapter I. This process is compounded when attempting to measure the inflation of all goods and services within an agency as complex as the DoD, in which analysts must develop inflation forecasts based on anticipated spending patterns that are subject to unforeseen price shocks caused by national and world events. Inflation forecasts also provide Congress future expenditure requirements for long-term DoD programs, which are revised annually. This chapter will discuss inflation, price indexes, key agencies that forecast inflation, the impact of inflation on the military, and finally, provide the reader with a literature review of previous inflation forecasting research.

Inflation

Inflation is commonly defined as generally rising prices over time for goods and factors of production or “the change in the price of goods and services [over time] while quantity and quality remain constant” (Jack, 1997:1). The OSD document, National Defense Budget Estimates for FY 1998 (1997) provides a similar definition and precautionary assessment about its variability:

Inflation is an increase in the general level of prices in the economy. Inflation does not mean that prices rise evenly or that all prices are rising. Some prices may be constant and others actually may be falling. Prices of some commodities rise faster than others because of differences in the magnitude and direction of changes in supply and demand in various markets. (45)

While inflation plays a key role in the computation of future defense budgets, inflation itself is outside the control of the DoD and to a large extent, the Federal government.

Taliaferro (1977:1) describes inflation as “the result of the deliberate but flawed intervention of the central government attempting to bring about high employment by the manipulation of aggregate demand in the face of increasing resource costs”. According to Jack, “price levels and inflation are determined by free markets, Government policy, and international events” (1997:6). In 1996, the constant dollar annual defense budget only amounted to approximately 3.3% of the U.S. Gross Domestic Product (GDP) which is less than 1% of worldwide spending (CBO, 1996). Future inflation is created by the aggregate spending habits of entities such as individuals, corporations, and other countries. Private investors and financial officers of major corporations anticipate future inflation rates, then organize their debt structures, investment portfolios, and spending

patterns accordingly. On an international scale, monetary policies of other countries such as Germany and Japan; and economic communities such as the European Union (EU) significantly impact future inflation in the United States.

Price Indexes. The Federal government measures current inflation, after the fact, through agencies such as the Department of Labor's Bureau of Labor Statistics (BLS) and the Department of Commerce's Bureau of Economic Analysis (BEA). Measuring inflation involves the collection of data from pre-determined reporting mechanisms, applying a specific methodology to determine its value, and publishing the value based on a price index. The annual cost of living increase the DoD pays its employees, for example, is based on a price index. Inflation is usually reported using a base year value of 100. A value higher than 100 for a future period indicates inflation and a lower number signifies deflation. Gill (1996) cited limitations on the effectiveness of price indexes to accurately measure inflation over time and listed the following general categories: 1) Statistical problems; 2) Sampling of items; 3) Sampling over time; 4) Sampling over geographic areas; 5) Quality changes and changes in taste; 6) Transaction prices versus list prices; and 7) Sampling Errors in the Indexes (32-36). Aside from the inherent limitations described in the cited text, price indexes offer valuable information and a standardized measurement tool to gauge the experienced inflation rate and anticipate future inflation. For example, Smith (1976) advocated the use of price index numbers in DoD contract pricing in the form of economic adjustment clauses for unexpected inflation to help save the government time and money obtaining scarce resources such as fuel and titanium.

In addition to yearly pay increases to maintain its force of trained and specialized personnel, inflation also causes DoD to pay increasingly higher amounts for its technologically sophisticated weapon systems. Common indexing approaches such as price indices used to measure DoD inflation include the Employment Cost Index (ECI), used to adjust military pay and entitlement programs. Of several different measures of inflation, the OSD(C) listed three primary indices used in the National Defense Budget Estimates for FY 1998 (1997:45):

1. GDP Implicit Price Deflator. The ratio of GDP in current prices to GDP in constant prices.
2. Consumer Price Index (CPI). Measures the average change in the prices of a fixed list of goods and services purchased by families and individuals in urban areas across the country.
3. DoD Purchase Index. Outyear projections based upon fiscal guidance from OMB linked to actual DoD purchase price experience calculated by the BEA.

This research will focus on the GDP IPD which is, “Generally regarded as the best single measure of price movements in the economy” (National Defense Budget Estimates, 1997:45). The GDP IPD is used to anticipate future inflation in military non-pay and non-fuel expenditures which includes new acquisitions, operations expenditures, and maintenance expenses.

The OMB and CBO both publish GDP IPD inflation estimates based on independent methodologies which include predictions based on parametric models and aggregation of current economic data. The different methods of estimation result in

variation between OMB and CBO forecasts of the GDP IPD. Given that the primary goal of both OMB and CBO is to help describe and predict the economic results of decisions made by their respective branches of the federal government, the following information will provide some necessary background on each agency.

Office of Management and Budget. The OMB was established in 1970 with responsibilities that include: supervising and controlling the yearly budget, assisting in development of regulatory reform proposals, providing the President with program performance data, and assisting the President with annual budget preparation. To estimate inflation rates, the OMB uses complex econometric models. These models represent how certain variables were related in the past, which include: production opportunities, time preference for consumption, and current inflation rates, among others (OMB, 1997). The Director of the OMB, Secretary of the Treasury, and the Chair of the Council of Economic Advisors (CEA) form a group known as *Troika*, which formulates five year projections on economic statistics which include the Gross Domestic Product (GDP) IPD (inflation), fuel prices, and interest rates. The assumptions of *Troika* are deemed political since it assumes positive growth in the economy, progress in lowering unemployment to an acceptable level, and progress toward balancing the federal budget (Belongia, 1988).

Belongia (1988) reported OMB inflation forecasts actually represent administration policy goals, fiscal policy goals, and the Federal Reserve Board (FRB)'s monetary policy rather than unbiased and objective estimates. The forecasts from OMB are spoken of as economic assumptions to be used in budgeting, but by nature of their

role in the political process of developing the budget, they represents the President's opinion of the economic forecast which is usually optimistic. Former OMB Director Stockman stated that inflation forecasts, "contain judgmental factors based on various beliefs or doctrines about how the economy responds and functions to change(s) in policy" (Congress, 1981:13). Every January, the OMB publishes the Budget of the United States Government, Fiscal Year 19xx (Unified Federal Budget) which includes defense expenditures based on the military's Planning, Programming, and Budgeting System (D'Angelo, 1997). The expenditures by the military services are developed using inflation forecast rates mandated by the OMB.

Congressional Budget Office. Congress, which is constitutionally empowered to approve spending on military programs, routinely evaluates military programs through its own Congressional Budget Office (CBO). The CBO was created by the Congressional Budget Act of 1974, which allows it to independently consider the Unified Federal Budget, make overall recommendations to Congress regarding spending and taxing levels, and track the deficit or surplus the budget may incur. The CBO provides Congress with basic budget data and an analysis of alternative fiscal, budgetary, and programmatic policy issues. Other major responsibilities include: economic forecasting and fiscal policy analysis, score keeping (monitoring the results of Congressional action against budget targets), cost projections, and an annual report on the budget (CBO, 1997).

To evaluate DoD expenditures, the CBO estimates and publishes independent inflation rate forecasts and projections in its publication, The Economic and Budget Outlook which utilizes the Consumer Price Index (CPI), among others, as a measure of

inflation. Recently, the CPI has drawn criticism for its inability to account for the substitution effect when consumers purchase goods and services. Stanford University economist Michael Boskin, recently appointed by Congress to investigate bias in the CPI, has reported the CPI may be too high. Using a different approach to analyze the data to measure consumer inflation, his report showed a CPI of 2.9 percent in 1996, which was lower than the official rate of 3.3 percent. Other reports indicate the CPI may be overstating inflation by as much as 1.1 percent (Carlson, 1997). If CBO inflation forecasts actually exhibit this upward bias, this may help explain its criticism of DoD estimates as having a downward bias. Military inflation estimates might be considered optimistic if the CBO measurement index used to evaluate inflation exhibits an upward bias.

Inflation Policy. The United States Government did not require all Federal agencies to anticipate inflation in the Unified Federal Budget until May, 1979. Before that, the OMB had a "government-wide policy of not allowing budgets to include funds for anticipated inflation, as set out in OMB's Circular A-11" (Congress, 1981:5). As an exception to this policy, the military was allowed to budget for anticipated inflation for its shipbuilding program in the 1960's. This practice signaled the beginning of budgeting for inflation in the DoD. In 1970, the House Armed Services Committee suggested the military utilize realistic and consistent inflation forecasts when budgeting for major weapon systems. The OMB responded by allowing the DoD to include anticipated inflation in its Procurement and Research, Development, Testing, and Evaluation accounts. In 1973, the OMB assumed control of forecasting DoD inflation and continued

to add inflation adjustments to more programs throughout the 1970's. By 1979, the OMB amended its Circular A-11 to direct all Federal agencies to include OMB mandated inflation forecasts in all budget requests (Congress, 1981).

Military Inflation. Given the fact that military acquisition programs incorporate state of the art technology, the use of exotic materials, long-term procurement, and higher standards of performance and reliability, it is not unexpected for inflation on these systems to increase at a rate higher than the average of all goods and services produced in the United States. Spencer (1971) evaluated economic theory of price index numbers from 1920 to 1970 and the establishment of a military price index using theoretical and practical considerations. His research recommended a Military Price Index (MPI) based upon "the chain index form of Fisher's *ideal* index or Theil's geometric index for the following uses: 1) to measure price inflation; 2) to be used in escalation clauses in contracts; and 3) for forecasting future price indexes" (Spencer, 1971:122). Congress (1981) previously concluded "The DoD has consistently experienced greater inflation than that experienced by the general economy. Evidence indicates that this experience is likely to continue" (3). The DoD budget contains several accounts in which different inflation forecasts are applied as deemed necessary, however, the aggregate average DoD inflation forecast is required to match the OMB mandated inflation forecast.

When inflation reached historical levels in 1980 and 1981, Congress made the following recommendation to the OMB: "The Director of the OMB should develop a separate inflation prediction for use as a management tool for DoD budgets. This defense inflation factor should be a realistic assessment of the future course of prices of goods

and services to DoD" (1981:3). In 1980, the Bureau of Economic Analysis (BEA) developed a preliminary DoD inflation index, based on goods and services purchased in the 1970's, from its National Income and Product Accounts (NIPA). Between 1972 and 1980 the index averaged 0.6 percent higher than the GNP rate used by the OMB. However, this exploratory defense price index was never utilized by the DoD. DoD program specific inflation factors have been and continue to be used on existing military programs. Research indicates program inflation estimates for non-pay and non-fuel program elements primarily utilized the GNP IPD through 1991, and then the GDP IPD since 1992, not the DoD Purchase Index.

According to the OMB Circular A-11 (1996), the DoD is encouraged to use inflation rates higher than the mandated OMB rate on programs inclined to experience higher inflation. However, the aggregate inflation rate for military spending categories such as non-fuel and non-pay expenditures must not exceed the mandated inflation rate. In order for this practice to maintain an unbiased inflation estimate, the expenditures on military purchases expected to experience lower than the mandated inflation rate, such as computers and electronics, would need to offset the expenditures on those military purchases that experience higher than the mandated inflation rate, such as advanced weapon systems. Since GDP is an aggregate expenditure measure of all U.S. goods and services, the OMB, by using the GDP IPD, assumes military expenditures will experience the average inflation rate of the overall economy rather than higher rates exhibited by industries such as health care and college education.

In a speech at the 30th Annual DoD Cost Analysis Symposium, Jack made the following remarks about current inflation policy and the DoD (1997:12):

1. The rate and extent of future inflation can be influenced by policies.
2. The government needs to forecast inflation to project future revenues and spending.
3. The DoD programs and budgets on the basis of projected inflation.
4. Fractional changes in inflation forecasts can have multi-billion dollar effects on programming.

Every January, the DoD updates funding requirements for defense related programs to reflect new acquisition programs, updated operations and maintenance expenditures, current-year inflation rates and an adjusted estimate of anticipated inflation over the next five years. According to Jack (1997), these rates are in accordance with OMB guidance, with “no special consideration of DoD, except for military pay policy” (12).

When forecasting DoD inflation rates, Jack (1997) described three broad categories used by OSD planners: Personnel Expenditures; Fuel Rates; and Other Purchases, which currently includes all non-pay and non-fuel expenditures.

The total DoD allocation from OMB is comprised of outlays matched against budget authority and is commonly described by the OSD as the DoD Topline (1997). Military and civilian pay, based on the Employment Cost Index (ECI), is now approximately 45 percent of the DoD Topline. Military pay is currently budgeted 0.5 percent less than the ECI rate while civilian pay is now budgeted at 1.5 percent less. These figures are subject to variation every year due to adjustments in the Unified Federal Budget proposal and what is actually enacted by Congress.

Fuel rates, now approximately two percent of the DoD Topline, are primarily based on the Refiner's Acquisition Cost (RAC) and subsequently modified by the Defense Logistics Agency (DLA). In the past (1973-74 and 1979-80), fuel rates were very volatile which created the need to track fuel rate inflation as a separate cost category. However, fuel rates have remained relatively stable over the last decade.

The last category is Other Purchases, now approximately 53% of the DoD Topline, which includes non-pay and non-fuel military expenditures. Inflation in DoD Other Purchases is currently based on the GDP implicit price deflator (IPD).

The Impact of Inflation Forecasts. This research effort concentrates on forecasts of the GDP IPD used to anticipate inflation in non-pay and non-fuel expenditures described by Jack (1997) as Other Purchases. Anticipated inflation rates also have a dramatic effect on the original decision to acquire various weapon systems. According to Dr. Gill at the Air Force Institute of Technology:

Obviously, we need to know the size of our future budgets in order to make plans but also, if those future budgets are changing in real (inflation-adjusted) terms, the mix of our future weapon systems will undoubtedly be affected. Inflation can have an important impact on our choice of alternatives if we expect the real cost of those alternatives to change relative to each other with time." (1997: 46)

For example, the decision between acquiring equivalent combat power of ten attack helicopters (\$10 M each) verses five attack aircraft (\$20 M each) may seem like an even cost of \$100 million dollars. But if the underlying inflationary pressure is greater in one system relative to the other system based on a longer acquisition period or other

inflationary factors, one system can end up being significantly more expensive to procure and operate over its life cycle.

By using lower inflation rates in the 1997 FYDP versus rates used in the 1996 FYDP, the DoD estimated a net expenditure decrease (savings) of \$34.7 billion dollars over the five year programming period. Congressional estimates of inflationary savings, using the CPI as a price measure, were \$10.3 billion which was \$24.4 billion less than the DoD estimate (GAO, 1997:2). The GAO conducted its own analysis of FYDP inflation savings (FY 1997 to FY 2001) and produced the information in Table 1 in 1998 constant-year dollars (GAO, 1997:7).

Table 1. GAO Comparison of 1996 to 1997 FYDP Changes by Primary Accounts
(Billions of 1998 Constant Year Dollars)

Account	1997	1998	1999	2000	2001	Total
Military Personnel	2.3	1.0	0.4	0.2	0.8	4.7
Operations Maintenance	-1.5	-1.3	-2.6	-2.5	-2.2	-10.1
Procurement	-4.6	-5.9	-3.7	-4.6	-7.2	-26.0
R&D, Test, Evaluation	2.0	3.3	2.8	1.7	1.1	10.9
Military Construction	0.4	0.2	0.3	0.3	0.3	1.5
Family Housing	-0.5	-0.3	-0.3	-0.4	-0.5	-2.0
Revolving, Contingencies	1.3	1.2	0.9	0.9	0.7	5.0
Total FY 1996	244.4	250.8	257.3	267.1	277.5	\$1,297.1
Total FY 1997	244.0	249.0	255.1	262.5	270.4	\$1,281.0
Net Changes	-0.4	-1.8	-2.2	-4.6	-7.1	\$-16.1

As shown in Table 1, the GAO estimate, \$16.1 billion dollars, was \$18.6 billion dollars under the DoD estimate and \$5.8 billion dollars over the CBO estimate.

Assuming the GAO report is unbiased and neutral in its analysis, the DoD estimate can be described as having an optimistic view of anticipated inflation, or downward bias, while the CBO estimate can be viewed as pessimistic, or exhibiting upward bias.

Review of Related Literature

Several government and private agencies predict future inflation using various methodologies and time spans. Congressional appropriations are budgeted using

anticipated inflation rates developed nine months before the budget year begins on October 1st and 21 months before it ends on September 30th the following year. Studies involving historical DoD inflation are primarily found in government publications by agencies such as the CBO, OMB, GAO, and the DoD.

The Federal Reserve Board (FRB) publishes research that focuses on forecasting interest rates, which have a tremendous effect on business, personal income, and consumer spending, thus impacting the overall economy. Interest rate forecasts by the FRB avoid undue influence from the Administration, Congress, and private agencies primarily due to its independent structure within the government and sole oversight of monetary policy. The FRB, through its Federal Open Market Committee (FOMC), establishes certain lending rates between institutions and allows the bond market, through open market trading, to establish the pricing on private and Treasury securities (Hosey, 1997). Finally, it is generally believed by economists that future interest rates are influenced by current and anticipated inflation rather than anticipated inflation being influenced by interest rate estimates (Connair, 1997).

The Treasury Yield Curve is a composite index of interest rates paid on U.S. Securities ranging from three-month bills to 30-year bonds. Clark (1996) reported that the Treasury Yield Curve successfully predicts interest rates and inflation. When the Yield Curve is plotted over time, a steep curve represents economic strength (low interest rates and low inflation) and a flat curve represents economic problems (high interest rates and high inflation). Overall, this indicator predicts the direction inflation is headed, either higher or lower. The orientation of the yield curve can change dramatically if the bond

market senses future inflation while at the same time, the FRB does not anticipate future inflation (Hosey, 1997). Also, an inverted yield curve, which may predict a recession, results when short-term interest rates are higher than long-term interest rates (Connair, 1997). Overall, the yield curve has limited value for the military since FYDP inflation estimates require specific yearly values over a six year time horizon while the yield curve only provides an indication of the direction interest rates are headed, either higher or lower.

McNees (1994) examined historical forecasts of real Gross National Product (GNP) which were used by the OMB until the benchmark change to GDP in 1992. This research evaluated the feasibility and reliability of estimating future inflation rates by the CBO, OMB, and private agencies. Instead of evaluating the forecast estimate compared to the actual inflation rate, the analysis considered confidence levels based on uncertainty analysis. McNees' findings indicated estimates of forecast uncertainty for most organizations were reliable at the 50 % and 90 % confidence level and all agencies evaluated performed relatively the same.

A CBO appendix to The Economic and Budget Outlook, *Evaluating CBO's Record of Economic Forecasts* (1996) provided a 13 year study of historical CBO, OMB, and Blue Chip estimates of the following indices: growth in real (inflation adjusted) output, the Consumer Price Index, and interest rates. When two-year average rates were evaluated, CBO's findings indicate its forecasting accuracy has been slightly better than the OMB and about even with Blue Chip Forecasters, which was used in the study to represent an efficient forecast. The study also indicated both the OMB and CBO leaned

toward optimism in their forecasts of real GNP/GDP. At the same time, the Administration was also credited with optimistic inflation forecasts as reported by Belongia (1988). The CBO (1996) stated, "selecting a historical series was difficult because of periodic benchmark revision of the actual data" (18). The periodic revisions include the transition from GNP to GDP and adoption of a chain weighted methodology from the previously used fixed-weighted methodology. The CBO (1996) also cited the following difficulties dealing with price level adjustments:

By periodically updating the series to reflect more recent prices, BEA's benchmark revision yield(s) a measure of real output that is more relevant for analyzing contemporary movements in real growth, but the process makes it difficult to evaluate forecasts of real growth produced over a period of years for series that are subsequently discontinued. (18)

To alleviate these problems, the CBO study based its historical analysis on a two-year, annual year basis and used the chain-type, annual-weighted GDP index as the actual rate. Perhaps the greatest limiting factor to this study's applicability to this research is that it utilizes real GDP, which excludes inflation.

Future Years Defense Program. The DoD FYDP describes planned military budget expenditures over a six-year time horizon. Previously, it has been named the Five Year Defense Program (FYDP) and Six Year Defense Program (SYDP). In 1992, it reverted back to its original acronym, FYDP, in which the "F" represents Future instead of Five. The FYDP is updated yearly to account for adjustments in inflation estimates, program transfers, and program changes. D'Angelo (1997) describes five separate Congressional appropriations as inputs to the FYDP process that require estimates to anticipate future inflation. While the FYDP is a classified document, the unclassified

information pertinent to this research was obtained from the Under Secretary of Defense (Comptroller) publication, National Defense Budget Estimates for FY 1998 (1997), commonly referred to as the *Green Book*, which provides the inflation forecasts used to estimate future program expenditures. When published in January, the *Green Book* provides the final historical inflation rate (actual) of the completed fiscal year, updates the budget year estimates, provides updated estimates that supersede five previous FYDP estimates, and adds a new FYDP outyear (Connair, 1997).

In addition, the USD(C) provides the Secretaries of the Military Departments with updated inflation guidance for budgeting military expenditures in January. According to Revised Inflation Guidance Memorandum (1997), "These revised rates are to be reflected in the FY 1998 President's budget submission and supporting congressional justification materials; the FY 1998-FY 2003 Program Objective Memoranda (POM); and the Selected Acquisition Reports (SARs) ..." (Maroni, 1997:1). These documents ensure the vast network of DoD agencies are provided the latest approved budget numbers and inflation estimates without discrepancies or disagreements among the services. D'Angelo (1997) describes the DoD coordinated effort to establish consistent and accurate financial information as extremely advantageous when the defense expenditures are debated by Congress. The price escalation indices within the Comptroller's guidance are divided into Outlays which have the following seven sub-categories: 1) Procurement; 2) Research, Development, Test, and Evaluation (RDTE); 3) Military and Family Housing Construction; 4) Operations and Maintenance (O&M) excluding fuel; 5) O&M Fuel; 6) Military Personnel Non-Pay; and 7) Medical (Maroni, 1997).

The categories of future military appropriations are placed into three groups when forecasting future inflation according to Jack (1997). Table 2 describes military and civilian pay, military fuel, and other purchases along with the current index used to anticipate its inflationary growth and the defense budget percentage (Jack 1997):

Table 2. Primary Price Indexes Used to Estimate Future DoD Inflation

Category	Price Index	Percent of Overall DoD Topline
Military and Civilian Pay	Employment Cost Index (ECI)	45 %
Military Fuel	Refiner's Acquisition Cost (RAC)	2 %
Other Purchases(Non-Fuel and Non-Pay)	GDP Implicit Price Deflator (IPD)	53 %

Another important category, adjustments by Congress, has a considerable impact on changes to the FYDP from year to year. Congressional adjustments are basically random events impacted by world events and the political climate which is not subject to an index. Still, it's important to track Congressional adjustments to realistically compare the magnitude and variance of all adjustments to the FYDP made every year.

Gross Domestic Product Implicit Price Deflator. Adjustments to anticipated inflation for Other Purchases are currently estimated using the GDP IPD, as mandated by the OMB. According to the GAO, "DoD's non-pay and non-fuel expenditures (Other Purchases) are subject to this lower GDP IPD inflation rate range from about \$138 billion to about \$166 billion for fiscal years 1997 to 2001, (which comprises) over 50 percent of

the DoD's budget" (1997:3). Table 3 describes information provided by Jack (1997) and lists the overall effect of changes to Other Purchases experienced by the FYDP from 1997 to 1998. The Pay, Fuel, and Congress Changes includes Military and Civilian Pay Adjustments, Fuel Adjustments, and Adjustments by Congress. The Other Purchases percentage change, Table 3, row nine, describes the relative proportion of Other Purchases to all other adjustments to the FYDP combined. The percentage value is derived by dividing the absolute change in Other Purchase by the absolute sum of pay, fuel, Congress, and Other Purchase adjustments. This demonstrates the variability of Other Purchases compared to the fuel and pay categories, which remain relatively stable over time. Other Purchases adjustments compared to total program changes range from 13.6% in FY 01 to 46.2% in FY 98.

Table 3. Percentage Effect of Other Purchase Adjustments to the FYDP
(Billions of 1997 Current Year Dollars)

Category Adjustment	FY97	FY98	FY99	FY00	FY01	FY02	FY03
FY 97 FYDP	244.0	249.0	255.1	262.5	270.4	277.4	284.1
Pay	0.0	0.0	0.0	-0.1	-0.2	-0.3	-0.5
Fuel	0.0	0.2	-0.1	0.1	0.1	0.1	0.1
Congress Changes	7.6	3.6	2.7	1.9	1.1	2.2	2.6
Other Purchases	0.0	-0.6	-0.5	-1.0	-1.2	-1.2	-1.0
Net Adjustment	7.6	3.2	2.1	0.9	-0.2	0.8	1.2
FY 98 FYDP	251.6	252.2	257.2	263.4	270.2	278.2	285.3
% Other Purchases	NA	13.6%	15.2%	32.2%	46.2%	31.6%	23.8%

Historically, the OMB relied on Gross National Product (GNP) IPD estimates to forecast inflation in Other Purchases. In 1992, the Department of Commerce's Bureau of Economic Analysis (BEA) adjusted its national income and product accounts (NIPAs) to calculate the GDP IPD and the OMB revised its estimates accordingly. Using historical BEA reports on GDP along with other economic analysis and unpublished methods, *Troika* forecasts the GDP IPD and the OMB mandates these rates on all Federal agencies to include the military services (Jack, 1997). Past inflation forecasts and economic

estimates by *Troika* and the President's Council of Economic Advisors (CEA) have been described as being political in the sense of diverging from consensus estimates. Belongia (1988) describes these forecasts as representing, "*rosy* scenarios that are too optimistic about the prospects for strong growth and lower unemployment...even White House insiders have alleged that the CEA's numbers were *cooked* to portray favorable economic outcomes" (15). In the past, powerful government officials have defended the use of the GDP IPD to forecast DoD inflation. Former OMB Director Stockman testified before Congress, "The historically close relationship between increases in Defense prices and the GNP [now GDP] IPD suggests that continued use of the GNP [now GDP] IPD for overall defense inflation projections is an acceptable technique" (Congress, 1981:8).

Chain Measurement. In 1995, the BEA revised its GDP IPD measure from a fixed to chain weighted methodology. The CBO and *Troika* adopted this revision in their 1996 inflation forecasts, followed by the DoD conversion in 1997. The CBO describes chain measurement as:

A measure of real economic output in which prices in adjoining years are used to calculate the growth rate for total output. Because this measure uses prices in recent periods, it is a more accurate measure of real growth than traditional constant-dollar (fixed-weighted) measures that use prices for a specific base year. (1996:55)

According to the DoD(1997), this procedure adjusted for the over-estimates of decreasing cost industries such as computers which have a major segment of the DoD budget. With the chain measurement, the growth rate in 1995 was reduced by 0.5 percent, which increased the GDP IPD by 0.5 percent. Currently, the OMB plans to implement the revised chain-weighted GDP forecast in its FY 2004 outlays which will impact DoD

budget authority and Total Obligation Authority beginning in FY 2000 (Jack, 1997). The OMB adoption of the chain-weighted from the previous fixed-weighted methodology to forecast future GDP IPD rates will change future inflation estimates. The chain-adjusted GDP IPD rates obtained from National Defense Budget Estimates for FY 1998, Table 5-10 (1997) are shown in Table 4.

Table 4. Effect of DoD Conversion From Fixed to Chain-Weighted GDP IPD

Year	Fixed-Weighted	Chain-Weighted	Difference
1980	8.8	8.8	Same
1981	10.0	9.7	-.3
1982	7.3	7.1	-.2
1983	4.2	4.5	.3
1984	3.8	4.1	.3
1985	3.1	3.3	.2
1986	2.7	2.9	.2
1987	3.2	3.0	-.2
1988	3.0	3.5	.5
1989	4.2	4.2	Same
1990	4.1	4.1	Same
1991	4.3	4.3	Same
1992	3.0	2.9	-.1
1993	2.4	2.6	.2
1994	2.0	2.3	.3
1995	2.0	2.5	.5
1996	2.0	2.2	.2

As shown in Table 4, no adjustments were necessary in 1980, 1989, 1990, and 1991. The most significant change, 0.5 percent, occurred in 1988 and 1995. Although DoD

objectives are to adjust for over-estimates of decreasing cost industries, the chain-weighted conversion actually increased GDP IPD forecasts by an average of .11% from 1980 to 1996. The OMB policy to incorporate the chain-weighted methodology to measure future GDP IPD estimates will impact future military inflation estimates.

Summary

Inflation forecasts play a substantial role in developing the FYDP which programs a six-year future defense plan. GAO reports suggest that these inflation forecasts are overly optimistic and have a downward bias (1994 and 1997). The DoD currently utilizes the GDP IPD to forecast expenditures on Other Purchases, which now comprises 53 percent of the DoD budget. Further research is required to determine if such a downward bias exists. This research will focus on historical GDP IPD inflation forecasts from 1979 to 1996 used by the DoD to estimate future inflation. This chapter described inflation, price indexes, key agencies that forecast inflation, the impact of inflation on the military, and finally, provided the reader with a literature review of previous inflation forecasting research. The following chapters will describe the research methodology, results and discussion, and finally, conclusions and recommendations.

III. Methodology

Hypothesis

The primary purpose of this research was to determine whether historical DoD inflation estimates demonstrate a downward bias when compared to the experienced inflation rate as measured by the GDP/GNP IPD. To achieve this purpose, this analysis is structured in three phases: data collection, a sign test evaluation of bias, and descriptive statistical analysis to evaluate the accuracy of the various forecasts which will be described in this chapter. Each phase of this study will address the research questions developed in Chapter I:

1. Do historical FYDP inflation forecasts, as measured by the GDP IPD, demonstrate consistent variance compared to actual inflation as the forecast time increases from the budget year to the five year span? (Are short and long term forecasts equally accurate?)
2. Do historical DoD inflation rates, as measured by the GDP IPD, exhibit a downward bias when compared to the experienced rate?
3. Which GNP/GDP IPD forecasting agencies are consistently more accurate when viewed retrospectively in view of experienced inflation?

This chapter describes the research hypothesis, specific research questions, and the research procedure. By analyzing historical DoD inflation forecasts against the experienced inflation rate and comparing them to forecasts of other agencies, this study will investigate GAO assertions that OSD/OMB inflation forecasts are optimistic and

exhibit a downward bias. The following paragraphs will discuss the definitions of concepts used in this study, the research design, statistical testing used in the analysis, and finally, limitations to this research.

Definitions

Accuracy. The degree to which forecast values estimate actual outcomes. Measured by mean error, MAD and RMSE.

Bias. The difference between the actual inflation rates and the forecast inflation rates from a given agency as measured by mean error.

Efficiency. The level of dispersion of a forecast agency around the actual inflation rate as compared to the Naïve approach and other agencies.

Forecast. A short-term inflation estimate span from budget to two years.

Gross Domestic Product. The market value of all goods and services produced during a particular time period by individuals, businesses, and government in the U.S. whether they are U.S. or foreign citizens or American owned or foreign owned firms. It includes income earned by U.S. owned corporations overseas, by U.S. residents working abroad, but excludes income earned in the U.S. by non-U.S. residents.

GDP Implicit (Price) Deflator. The ratio of GDP in current prices to GDP in constant prices. It is an overall measure of the price level (compared with a base period) given by the ratio of current-dollar purchases to constant-dollar purchases.

Inflation. Previously defined as “the change in the price of goods and services while quantity and quality remain constant” (Jack, 1997:1). The OSD(C) defines inflation as, “an increase in the general level of prices in the economy”(1997:45).

Projection. A long term inflation estimate span from three to five years.

Agency Forecasts Evaluated: Actual GNP/GDP IPD rates, based on a fixed-weighted methodology and fiscal year time format, were obtained from the National

Defense Budget Estimates for 1998 (1997:59) and evaluated against the following agency forecasts:

DoD. The OSD Comptroller publishes GDP IPD forecasts as prescribed by the OMB. The OMB has historically used the GDP IPD developed by the Commerce Department's Bureau of Economic Analysis (BEA) and adjusted it to a fiscal year time format. The data set included 108 observations (budget year to five year span) from 1979 to 1996 obtained from National Defense Budget Estimates for 1998 (1997:59).

CBO. Congress relies on its own estimate of the GDP IPD provided by the CBO. The data includes 86 observations obtained from calendar year implicit deflator forecasts in annually published Congressional Budget Office publications, Baseline Budget Projections (1978-1983) and The Economic and Budget Outlook: Fiscal Years (1984-1996). In 1990, the CBO began publishing budget and one year GDP IPD estimate by Blue Chip Forecasters. This is a consensus forecast involving the average of about 50 economic forecasts as surveyed by Eggert Economic Enterprises, Inc. The CBO considers the Blue Chip forecast a measure of forecast efficiency as described in

Evaluating CBO's Record of Economic Forecasts (1996):

The Blue Chip consensus forecasts represents a wide variety of economic forecasters and thus reflect a broader blend of agencies and methods than can be expected from any single forecaster. The use of the Blue Chip forecasts in this evaluation can therefore be interpreted as a proxy for an efficient forecast. (21)

Since available Blue Chip forecasts are limited to budget and one year forecasts, these observations were excluded from the study.

DRI. Data Resources, Incorporated is a subsidiary of McGraw-Hill, based in Lexington, Massachusetts. They publish a three year, short term forecast which is updated every month and a long term projection which is updated quarterly. DRI data were provided by the Economics Division, Secretary of the Air Force Directorate of Economics and Business Management (SAF/FMCEE). Yearly, long-term estimates were obtained from 1981 to 1996 in calendar-year time format which included 81 budget through five year spans. The January 1985 forecasts were based on DRI's 25 year trend forecast and the January 1987 estimates were extrapolated from their Spring 1987 and Fall 1988 forecasts. Finally, DRI revised its forecast over time as follows: 1981, Implicit Price Deflator; 1989, GNP Price Deflator (Implicit); 1991, GDP Price Deflator (Implicit); and 1995, GDP Implicit Price Deflator (Chain-Weighted). For this study, all forecasts were considered the same measure.

Naïve. The naïve approach simply states that the most recent inflation rates will prevail and remain the same into the future. The Naïve forecast will be used to help evaluate efficiency by comparing other forecasts against it. If another source cannot provide better forecasts than the naïve approach, then resources and effort spent on those forecast agencies demonstrate non-effectiveness toward the overall objective to provide an accurate estimate.

Time Periods. The yearly forecast dates evaluated coincide with CBO, OMB, and OSD economic reports normally published in January. The six forecast spans evaluated include the budget year and one through five outyear estimates listed in the National Defense Budget Estimates for FY 1988 (1997:59). These forecasts are out of

phase with the six FYDP years by one year since the FYDP includes outyears one through six and excludes the budget year. In addition, missing time periods were indicated by a “ * ” as applicable with a complete listing provided in Appendix A.

Research Design

This research is based on ex-post facto comparative research of secondary data centered on the null hypothesis that DoD inflation rate forecasts have no bias which means the likelihood of over-forecasts are approximately equal to the likelihood of under-forecasts. The procedural steps involved include gathering relevant historical inflation forecasts, loading the information into a computerized spreadsheet program, conducting non-parametric analysis utilizing the sign test and an accuracy comparison based on statistical analysis.

Data Collection. Historical inflation forecasts were gathered from the following agencies: DoD, CBO, and DRI. This study evaluates historical Gross National Product and Gross Domestic Product (GNP/GDP) IPD forecasts. In 1991, the basis for evaluating U.S. output at market prices changed from GNP to GDP which was reflected in the fiscal 1992 Unified Federal Budget. This complicates the effort to obtain consistent historical data to conduct the research procedure. However, according to the OSD(C), “the distinction between GNP and GDP is not very great for the United States because relatively few U.S. residents work abroad and U.S. earnings on foreign investments are about the same as foreign earning in the U.S.” (1997:3). Data for the Naïve approach were extracted from the actual GNP/GDP IPD rates experienced from 1978 to 1996. A

complete listing of the data, consisting of six spans (budget to five year) used in this research are listed in Appendix A.

Data Manipulation. To the maximum extent possible, forecasts were compared based on performance within equal time spans, excluding the differences between fiscal and calendar year forecasts. Since the analysis evaluates 18 years, the yearly difference between the fiscal and calendar year forecast is assumed to have a negligible effect on the descriptive statistics used in the analysis. In order to consolidate research findings, the time spans were divided into two categories, forecasts and projections. Forecasts include the budget, one, and two year time span while projections include the three, four, and five year time span. Each agency forecast and projection span was listed and analyzed separately in Appendix A, but overall results and implications were primarily based on short term (one year) and long-term (five year) results.

Testing

Research Question One. Historical DoD inflation estimates were evaluated to better understand the effectiveness of short-term compared to long-term forecasts as measured by total variance. Given that I_a = actual inflation, I_f = forecast inflation, and N = number of forecasts, variance is defined as:

$$\text{Variance} \quad \Sigma (I_f - I_a)^2 / N$$

The assumption that short-term forecasts will have less variance than the long-term forecasts was evaluated. Mincer (1969) discusses multi-year or multi-span forecasting and states:

On average, forecast errors increase with length or predictive span. One reason for this is that forecasts consist, in part, of extrapolations whose accuracy declines for more distant target dates. However, longer-term forecasts are generally worse than the short ones...Evidently, the predictive power of the autonomous components of forecasts deteriorates more rapidly with lengthening span. (46)

This analysis evaluated whether the methodology currently used by DoD for long term FYDP projections are able to efficiently estimate inflation when compared with DoD short term forecasts and the Naïve approach. DoD estimates were compared to the experienced inflation rate and the resulting variances were rank-ordered from lowest to highest. For visual comparison, the DoD four and five year projections were graphed against the experienced inflation rate with the results presented in Chapter IV.

Research Question Two. To evaluate the possibility of a downward bias in historical inflation estimates, the difference between the forecast inflation rate and the experienced inflation rate was evaluated using the sign test. According to Mincer (1969), “a forecast is unbiased if the mean values of the predictions and realizations are equal, that is, if the average error is zero” (41). This analysis evaluates the downward bias for each agency forecast using the following assumptions:

1. All forecasts attempted to estimate the actual inflation rate free from an upward or downward bias and have an equal likelihood to under-forecast and over-forecast. That is, forecast error is the only factor influencing the forecast.
2. The population distribution of the actual and forecast inflation rate error is symmetric around a mean of zero.

Since we have actual GNP/GDP IPD rates and historical forecasts, the procedure requires differentiation between forecasts found to be higher and forecasts found to be lower than the experienced inflation rate. Are the forecast minus the actual inflation rate differences distributed evenly about zero or about some other measure, which would indicate bias?

The analysis provides a one-tail test of up to 18 total observations, thus a normal approximation to the binomial was utilized based on the Winkler and Hays (1975) requirement for at least ten observations. Given N equals the number of unmatched observations and U equals the number of under forecasts, the sign test utilized the following formula to determine the observed value, or z-value (Winkler and Hays, 1975:856):

$$\text{Observed Value} = [U - N*(0.50) - .50] / [\text{SQRT } N*(0.50)*(0.50)]$$

These z-values were then used with normal probability tables to determine P-values (Newbold, 1990:888-890).

Hypothesis Testing. The test of research question two, historical DoD inflation rates have no bias, was based on the sign test, which Newbold (1991) describes, "Used for testing hypotheses about the central location of a population distribution and is the most frequently employed in analyzing data from matched pairs" (414). A "+" represents an over-forecast with a probability of 50% (.5) and a "-" represents an under-forecast with a probability of 50% (.5). If the forecast estimate was equal to the actual inflation rate, the observation was removed from consideration in the analysis. The null hypothesis in the sample of data analyzed states there was no overall tendency to under-

forecast inflation by the DoD and the population median of under and over-forecasts is zero (Newbold, 1991). What is the probability of our sample of inflation forecasts exhibiting a result higher than found if the null hypothesis is valid? For this research, under-forecasts are defined as those estimates that are less than the actual inflation rate and indicated by a “U” and subject to the following one-sided hypothesis:

Null Hypothesis. $H_0 : U \leq .50$

Alternative Hypothesis. $H_1 : U > .50$

The number of under forecasts (U) observed from 1979 to 1996 were reported along with its associated observed value and resulting P-value. Larger P-values indicate fewer under forecasts which does not support the GAO assertion that DoD forecasts exhibit downward bias. Smaller P-values indicate more under forecasts which supports the GAO assertion that DoD forecasts exhibit downward bias. A graphical representation of the research hypothesis is provided in Figure 1.

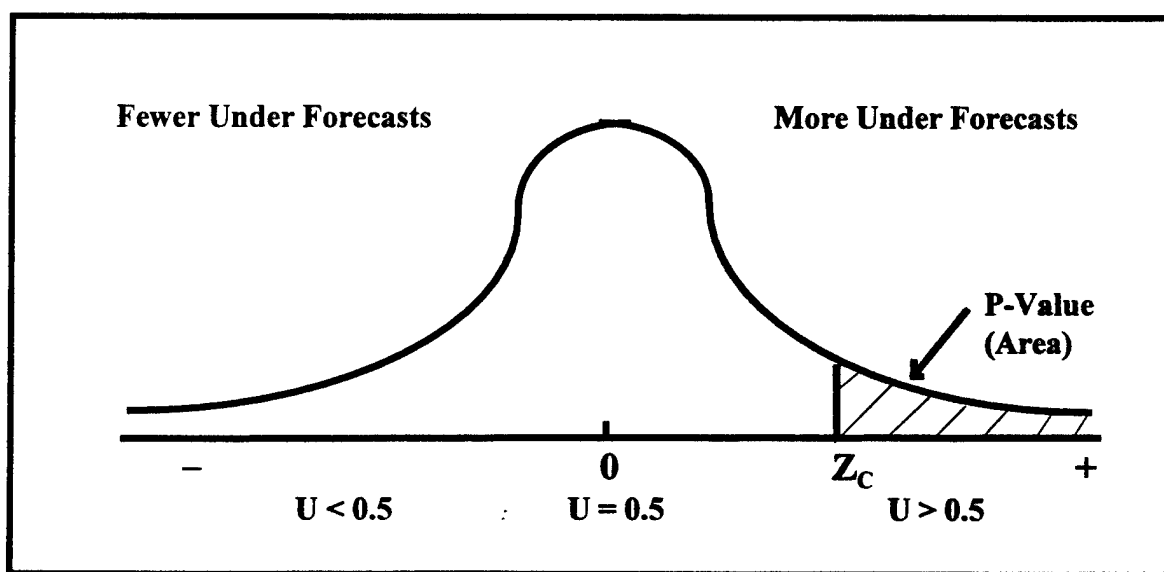


Figure 1. Graphical Representation of the Research Hypothesis

Research Question Three. This analysis evaluated which forecast agencies are consistently more accurate based on descriptive statistical analysis. Given the small sample size, Mincer (1969) recommends, “In dealing with limited samples of prediction and realizations, statistical tests are necessary to ascertain whether the forecasts are significantly biased or inefficient, or both” (44). Four statistical measures were used to evaluate the bias and accuracy of each agency forecast: variance, mean error, mean absolute deviation (MAD), and root mean squared error (RMSE). Variance was previously used to evaluate OMB and Naive forecast spans. Mean error measurements revealed the difference between the actual inflation rate and the forecast inflation rate to evaluate bias. MAD and RMSE measurements revealed the level of dispersion of each forecast around the actual rate, whereas more dispersion from the mean represented less accuracy. Given I_a equals actual inflation, I_f equals forecast inflation, and N equals the number of observations, the statistical measurement formulas are as follows:

$$\text{Mean Error} \quad \Sigma (I_f - I_a) / N$$

$$\text{Mean Absolute Deviation (MAD)} \quad \Sigma |(I_f - I_a)| / N$$

$$\text{Root-Mean Square Error (RSME)} \quad \text{SQRT} (\Sigma ((I_f - I_a)^2) / N)$$

Limitations

Experimental Design. This thesis is based on an *ex-post facto* experimental design consisting of an exploratory and analysis phase. The exploratory phase consisted of data collection and manipulation of the data. The analysis phase utilized the sign test and an accuracy comparison using descriptive statistics. The data were extracted from

historical records so no effort to control for extraneous variables was possible.

Interaction with a dynamic and often unpredictable environment was anticipated to be a major intervening variable. After inflation estimates were developed, major world events, business cycles, and government policy decisions that directly impact inflation rates cannot be controlled. Some of the significant historical adjustments that directly affect inflation research are included in Table 5.

Table 5. Historical Adjustments Affecting DoD Inflation Research

Year	Adjustment
1997	OSD(C) replaces fixed weighted with chain-weighted GDP IPD methodology
1996	Price level adjusted to 1992 basis
1992	The CBO, OMB, and Blue Chip changed from Gross National Product (GNP) to Gross Domestic Product (GDP)
1991	Price level adjustment to 1987 basis
1985	Price level adjustment to 1982 basis
1976	Federal Government Fiscal Year (1977) moved from July to Oct
1976	Congressional Budget Office established Price level adjustment to 1972 basis
1970	Office of Management and Budget established.

Threats to Internal Validity (Construct Validity). Characteristic of *ex-post facto* designs, this study was not able to control internal threats to validity. This is acceptable, because this study did not attempt to test for causation, but merely for bias

and accuracy. Several threats to internal validity make the establishment of a causal relationship impossible. First, fiscal and calendar year forecasts were evaluated together using the DoD fiscal year GNP/GDP (fixed-weighted) IPD as the single measurement baseline. Of the 216 months (18 years) evaluated, the difference between the fiscal and calendar year comparison consists of three displaced months, October through December, 1978 instead of October to December, 1996. In the 18 year period evaluated, the fiscal year actual rates sum to 78.8, while calendar year rates obtained from OMB (1997) sum to 78.4. Thus, the overall applicability of descriptive statistics will be relatively close while year by year comparisons between agencies will not be feasible.

Next, a history effect may be present in which political, social or technological changes may have occurred from year to year when computing inflation rate forecasts. An instrumentation effect is also possible because the requirements and practices for reporting the data have not been rigorously standardized across time. The selection of inflation forecast agencies may be systematically biased by the elimination of other agencies or measurements of inflation. The data used in this research are based on secondary sources and are deemed reliable. Inflation rate reporting is somewhat controlled through the use of certification procedures for data management, an audit function, and independent reporting. Therefore, the data which are reported are expected to be free of excessive manipulation.

Threats to External Validity (Generalizability). Threats to external validity may limit the generalizability of this study. Past information on inflation does not represent current and future methods involved in forecasting inflation rates because the

methodologies to forecast inflation are continually changed and updated. This research evaluates past GNP/GDP IPD estimates to better understand the past bias and accuracy of specified agencies that forecast inflation. Finally, the effectiveness of the GDP IPD, used as the instrument to represent inflation in DoD Other Purchases, was not evaluated.

IV. Results And Discussion

Findings

The GAO assertion that historical DoD inflation forecasts have a downward bias was tested and yielded mixed results. Within the six spans evaluated, the budget year, one, and two year forecasts do not indicate a downward bias while the three, four, and five year projections indicate a downward bias. Further, the four and five year findings are supported by a sign test of unmatched pairs, descriptive statistics, and graphical observations that demonstrate that a slight downward bias exists subject to the assumptions and limitations previously mentioned. Next, statistical results indicate DRI and CBO forecasts have less dispersion than DoD. This chapter will discuss the findings to the research questions, their relationship to cited research, and provide resolution of conflicting findings.

Research Question One. FYDP inflation forecasts spans, budget to five year, were evaluated by comparing average and marginal variance over the last 18 years. The short-term forecast spans exhibited less total variation than the long-term forecast spans which is consistent with the research assumption. Table 6 lists the forecast time span, Naïve and DoD forecast variance compared to the experienced rate, the marginal increase in DoD variance, and a rank-ordered comparison from lowest to highest variance.

Table 6. DoD and Naïve Inflation Forecast Variance Measurements

Forecast Time Span	Naïve Variance	DoD Variance	Marginal Variance	Rank Order (Low to High)
Budget Year	*	0.25	0.25	1
One Year	1.35	1.77	1.52	2
Two Year	3.77	3.55	1.78	3
Three Year	6.65	5.09	1.54	4
Four Year	8.89	6.31	1.22	5
Five Year	10.08	6.90	0.59	6

Table 6 results demonstrate DoD forecasts do not exhibit stationary variance about the actual inflation rate which is consistent with the findings of Mincer (1969). Short-term DoD forecast spans consistently have less variance than DoD long term spans. This is also logically consistent since long-term spans are subject to additional unknown variability. The most interesting result, Table 6, one year variance, indicates the one year Naïve approach has less variance than the one year DoD forecast. This indicates DoD efforts to provide a reliable one year forecast over the last 18 years were less successful (more variance) than if they had adopted the existing rate as the forecast rate for the next budget year. Further accuracy comparisons between DoD and Naïve forecasts are considered in research question three. A graphical description of the one year DoD and Naïve forecast spans are presented in Figure 2.

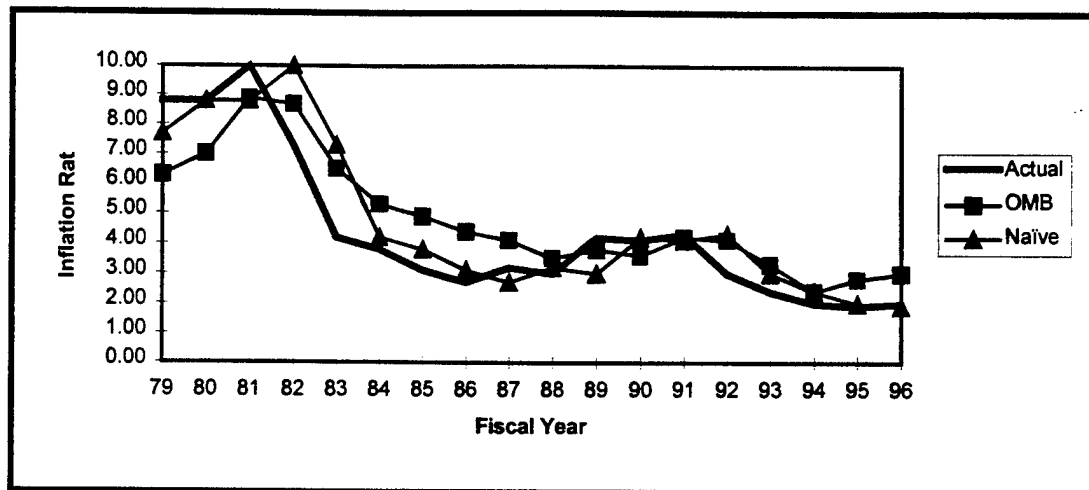


Figure 2. DoD and Naïve GNP/GDP Implicit Price Deflator Forecasts
(One Year Time Span)

Graphical observation indicates the one-year naïve approach approximates the actual inflation rate with less variance than the one-year DoD rate. Finally, research question one findings were consistent with previous research and assumptions.

Research Question Two. The sign test was used to evaluate if differences between under and over forecasts amongst the agencies were significant enough to statistically determine downward bias. Table 7 summarizes the test results and includes the forecast agency, number of observations, number of under-forecasts, the calculated observed value (z-value), and the resulting P-value. The P-value is the smallest level of significance at which the null hypothesis would be rejected. Thus, a lower P-value indicates more tendency toward under-forecasts which supports GAO assertion that DoD forecasts have downward bias. Based on an analysis of unmatched pairs, sign testing revealed a slight tendency for DoD four and five year projections to exhibit a downward bias as indicated in Table 7. The CBO and DRI forecasts revealed much higher P-values,

from 0.6255 to 0.9999, indicating a tendency toward over forecasts. Given the P-values for the four and five year DoD projection were 0.4052 and 0.2389 respectively, the statistical evidence for downward bias is thus not strong even in the most extreme cases. A graphical description of the four and five year DoD forecasts spans compared against the actual rate are presented in Figure 3.

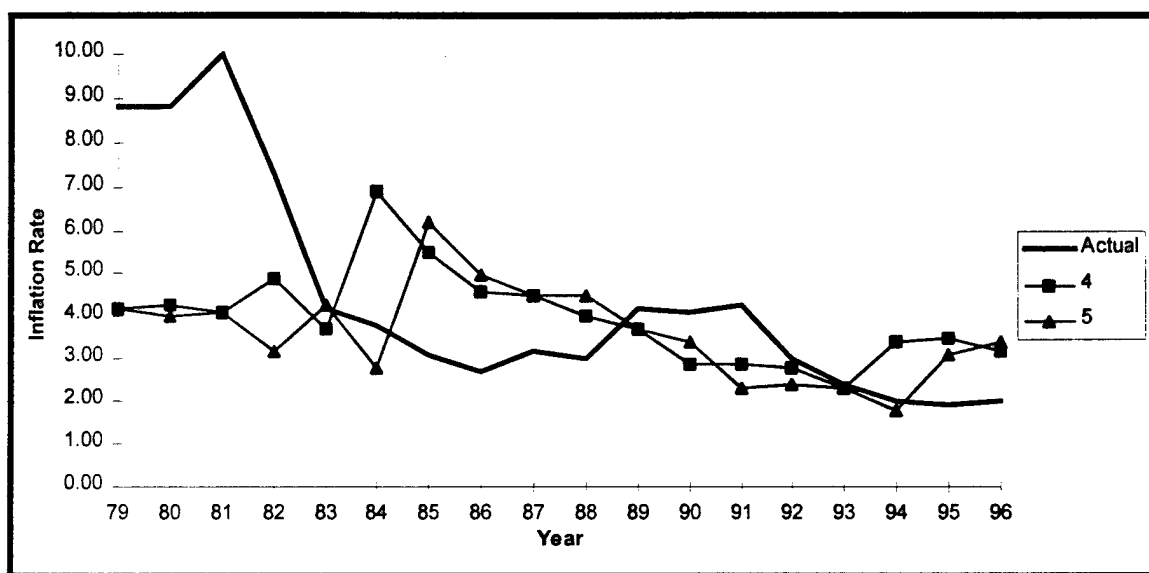


Figure 3. DoD GNP/GDP Implicit Price Deflator Forecasts
(Four and Five Year Time Span)

Figure 3 indicates DoD four and five-year forecasts have not underestimated inflation since 1993 and 1994, respectively. Under forecasts are grouped from 1979 to 1983 and 1989 to 1992 which indicates a cyclical effect. Figure 3 also reveals most DoD forecast variance existed between 1979 and 1982 when inflation rates were historically higher and more volatile. Given the sign test does not discriminate between the magnitudes of forecast error, DoD four and five year projection mean error differences were -0.41 and -0.76 respectively, as shown in Table 8. A visual review of other sign test

results in Appendix A indicate over and under forecast are clustered in groups, rather than randomized events. This cyclical pattern observed in agency inflation forecasts may indicate the forecasts follow a cyclical pattern, such as the business cycle. In summary, DoD four and five year projections exhibited only a slight tendency toward downward bias based on a sign test of unmatched pairs and evaluation of mean errors.

Table 7. Sign Test Results of DoD, CBO, DRI, and Naive Inflation Forecasts
(Historical forecasts versus the actual rate)

Forecast Agency/Span	Effective Observations (n)	Under Forecasts	Observed Value (z-value)	P-value
DoD				
Budget	15	4	-2.07	0.9808
One	18	6	-1.65	0.9505
Two	18	6	-1.65	0.9505
Three	18	8	-0.71	0.7611
Four	18	10	0.24	0.4052
Five	18	11	-0.71	0.2389
CBO				
Budget	12	2	-2.60	0.9953
One	16	3	-2.75	0.9970
Two	14	3	-2.41	0.9920
Three	14	3	-2.41	0.9920
Four	11	2	-2.41	0.9920
Five	12	1	-3.18	0.9993
DRI				
Budget	10	5	-0.32	0.6255
One	15	6	-1.03	0.8485
Two	14	4	-1.87	0.9693
Three	13	2	-2.77	0.9972
Four	12	1	-3.18	0.9993
Five	11	0	-3.62	0.9999
Naïve				
One	17	6	-1.46	0.9279
Two	17	8	-0.49	0.6879
Three	18	6	-1.65	0.9505
Four	17	5	-1.94	0.9738
Five	18	7	-1.65	0.9505

Research Question Three. After evaluating DoD FYDP forecast variance, testing agency forecasts for downward bias, and noting discrepancies, descriptive statistical techniques were used to analyze the accuracy of the each forecast agency. Each agency forecast span was tested for bias and dispersion. Bias represents the difference between the actual inflation rate and the forecast inflation rate measured by mean error. If the forecast errors are random (as they should be if our choice of forecasting method is appropriate) some errors will be positive and some errors will be negative, resulting in a sum near 0 regardless of the size of the individual errors. Since the mean error is the sum of forecast differences divided by the number of observations, the closer the mean error is to 0, the agency demonstrates it has less bias. To test for dispersion of the forecast inflation around the actual inflation rates, measurements of mean absolute deviation (MAD) and root mean squared error (RMSE) were evaluated and rank ordered from most accurate to least accurate. Since forecast values are rounded to the nearest 0.001, differences between statistical measures less than 0.0005 were not considered significant. The results of accuracy testing are listed in Table 8, Evaluation of Agency Forecasts.

Table 8. Evaluation of Agency Forecasts

Forecast Agency	Mean Error	Mean Rank	MAD	MAD Rank	RMSE	RMSE Rank
Budget						
DoD	0.25	3	0.38	2-3	0.50	1-2
CBO	0.33	2	0.38	2-3	0.51	3
DRI	-0.12	1	0.34	1	0.50	1-2
One						
DoD	0.44	3	1.16	4	1.33	3
CBO	0.69	4	1.11	3	1.43	4
DRI	0.15	1	0.51	1	0.59	1
Naïve	0.32	2	0.79	2	1.16	2
Two						
DoD	0.19	1	1.58	4	1.88	3
CBO	0.84	4	1.29	2	1.64	2
DRI	0.81	3	0.96	1	1.34	1
Naïve	0.56	2	1.38	3	1.94	4
Projection Agency	Mean Error	Mean Rank	MAD	MAD Rank	RMSE	RMSE Rank
Three						
DoD	-0.07	1	1.87	3	2.26	3
CBO	0.75	2	1.44	2	1.84	2
DRI	1.22	4	1.30	1	1.69	1
Naïve	0.76	3	2.06	4	2.58	4
Four						
DoD	-0.41	1	1.96	3	2.51	3
CBO	1.02	2	1.30	1	1.57	1
DRI	1.60	4	1.65	2	2.09	2
Naïve	1.16	3	2.33	4	2.98	4
Five						
DoD	-0.76	1	1.97	2	2.63	3
CBO	1.28	2	1.32	1	1.54	1
DRI	2.05	4	2.05	3	2.37	2
Naïve	1.48	3	2.42	4	3.17	4

The results demonstrate DoD had the lowest mean error during the two through five years spans. DoD short term forecasts (budget, one, and two year spans) exhibited a positive bias, 0.25, 0.44, and 0.19 respectively. Contrary to the short term results, DoD long-term projections (three, four, and five year) revealed a downward bias of -0.07, -0.41, and -0.76 respectively. With the exception of slight downward bias (-0.12) in the DRI budget year forecast, all other CBO and DRI forecasts demonstrated positive mean error indicating a tendency of upward bias over this period.

Forecast dispersion was evaluated using MAD and RMSE. The RMSE normally follows the same pattern as MAD, but due to the squaring of the error amounts, larger forecast errors will weigh more heavily in RMSE analysis than MAD analysis. Overall, smaller MAD and RMSE figures represent less dispersion in the forecast and, all else equal, less dispersion is better. Generally, the same conclusions were found with MAD as those found with RMSE. However, some MAD and RMSE values were mixed when analyzing the one-year CBO and DoD forecast spans and the five-year DoD and DRI projection spans. In terms of MAD, the DoD was most dispersed. In terms of RMSE, CBO and DRI were most dispersed.

Short-term MAD and RMSE results demonstrate all budget year forecasts were virtually the same. The one and two year forecast findings reveal DRI forecasts are the least dispersed and DoD forecast are the most dispersed. The CBO and naïve forecast dispersion was in between these results, with CBO exhibiting less dispersion than naïve. Long-term MAD and RSME results demonstrate CBO forecasts are the least dispersed and naïve forecasts are the most dispersed. The DRI and DoD forecasts dispersion was in

between these results, with DRI exhibiting less dispersion than DoD. Of notable significance and previously discussed in research question one, the DoD one and two-year forecasts were more dispersed than the naïve approach based on MAD and RMSE analysis. This shows DoD one and two year forecasts were less efficient than the Naive approach.

To better understand the overall effectiveness of the three agency forecasts and projections compared against each other, Figures 4 and 5 provide one year forecast and five year projection results. The figures also facilitate generalized results for DoD, CBO, and DRI forecast accuracy in the short and long run in a similar format to previous research. The figures are limited to years that contain estimates from all three agencies.

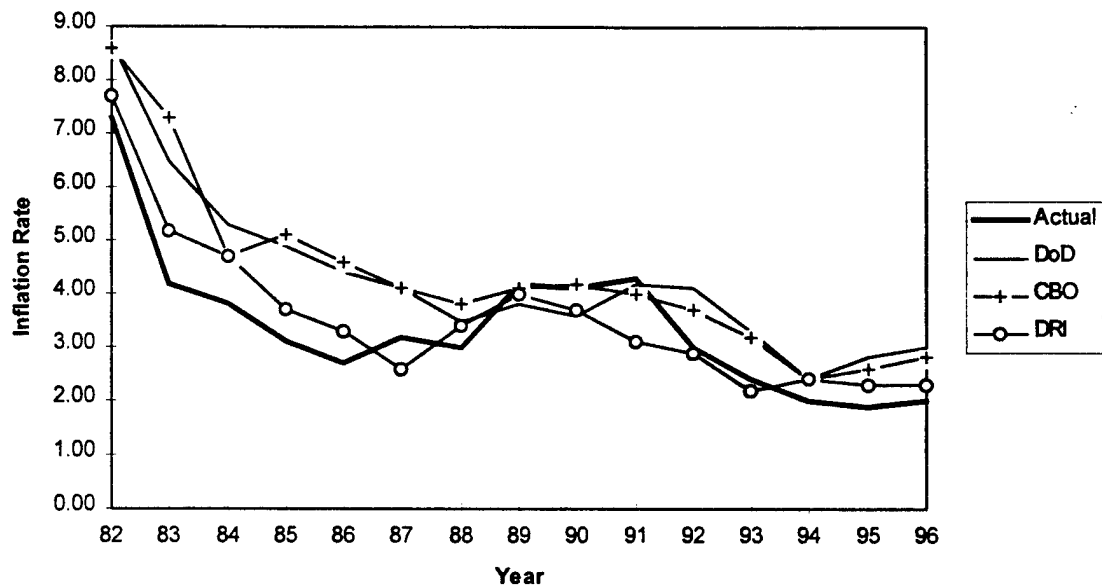


Figure 4. Comparison of DoD, CBO, and DRI One Year Forecasts

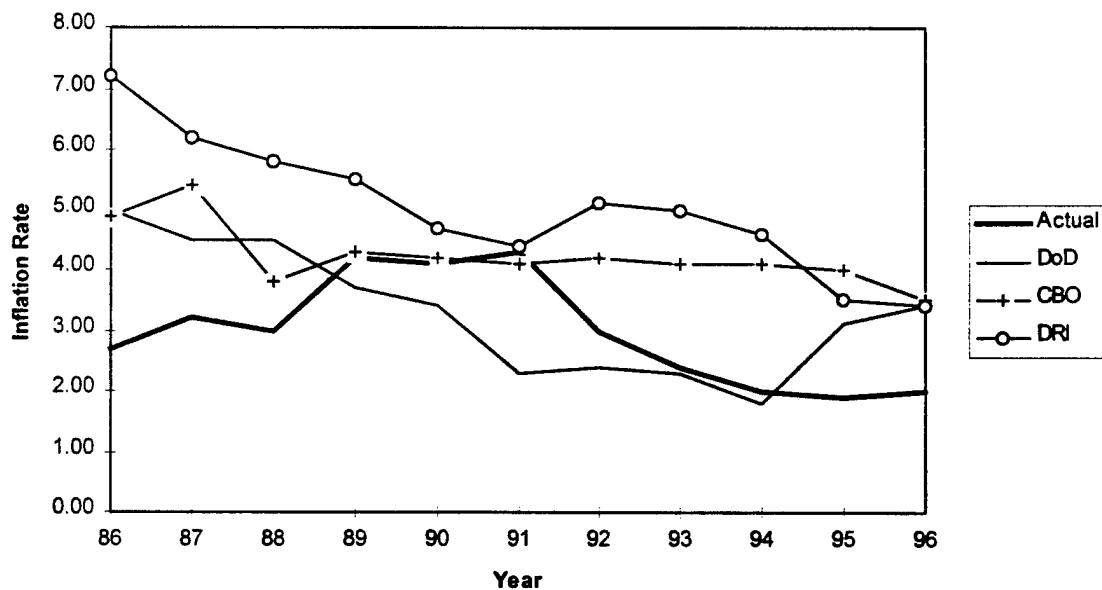


Figure 5. Comparison of DoD, CBO, and DRI Five Year Projections

The following summary provides overall findings pertaining to each agency evaluated in this analysis:

1. **DoD.** Based on mean error, they were the most accurate for the two through five year spans. The short-term forecasts demonstrated upward bias and the long-term projections demonstrated downward bias. The forecasts generally demonstrated slightly more dispersion than OMB or DRI.
2. **CBO.** Based on mean error, they were least accurate for the one and two year spans, yet second only to DoD for the three to five year spans. All forecast spans demonstrated upward bias. The four and five year projections exhibited the least dispersion.
3. **DRI.** All forecast spans except the budget year demonstrated upward bias. The one, two, and three year forecasts exhibited the least dispersion.

Overall, all agencies performed equally well forecasting the budget year. Agency forecasts became progressively worse as the time span changed from budget to five years. The results of mean error, MAD, and RMSE analysis were mixed.

Relationship to Cited Research

This research was a preliminary effort to constructively analyze the bias and accuracy found in historical DoD FYDP inflation estimates. The GAO assertion that DoD forecasts tend to under forecast were not supported by short term forecasts since they were shown, on average, to exhibit a positive mean error. Long-term DoD forecasts did exhibit a negative mean error, indicating possible downward bias, but statistical support was weak. Several past studies have examined forecasts of the OMB and CBO without considering the effect these forecast may or may not have on subordinate organizations like the Department of Defense. This analysis attempted to consider FYDP inflation estimates based on a fiscal year time format rather than a calendar year basis. The preference for the fiscal year evaluation was based on the availability data and a

desire to coincide with the Unified Federal Budget, Congressional appropriations, and the DoD budget cycle. Existing CBO research relating to GDP forecasting, *Evaluating CBO's Record of Economic Forecasts* (1996) focused on two year forecasts and five year projections of Real GDP, which excludes the effect of inflation. Since inflation is the unpredictable and continuously changing factor DoD attempts to anticipate, existing CBO research on the accuracy of Real GDP forecasts only partially relates to this research effort. The present findings partially confirm previous GAO reports that the DoD inflation estimates may exhibit a downward bias; but only in its long-term projections.

Resolution of Conflicting Findings

Most DoD forecast variance existed between 1979 and 1983 when inflation rates were historically higher and more volatile. CBO and DRI four and five year forecasts during this period were not evaluated due to missing data. Since overall inflation rates fluctuated heavily during that time, it's possible the CBO and DRI experienced similar forecasting errors. This research equally weights each year evaluated, therefore, missing CBO and DRI data during volatile inflationary periods (1979-1983) needs to be considered.

Next, Mincer and Cole (1969) discovered up to 30 percent of forecast errors result from errors in the current and historical data used to develop forecast models. Perhaps improved data gathering and computer automation have decreased this potential, but data errors must still be considered when evaluating this research. The data set used to evaluate the forecast agencies in this research have previously cited limitations due to the

relatively small sample size and availability of specific data. Other factors, as suggested in Chapter III, include changes in government policy such as the revision from GNP to GDP. Finally, all forecasts were assumed subject to the same time constraints even though some forecast estimates were published outside the month of January.

Summary

Historical FYDP inflation forecasts using the GDP IPD along with the previous measure, GNP, were the focus of this research effort. DoD forecasts exhibited increasing amounts of variance as the forecast span changed from budget to five years which is consistent with previous research. Analysis of DoD GNP/GDP IPD forecasts indicate no downward bias exist in short-term estimates while the long-term estimates demonstrate a slight tendency toward downward bias. The DoD four and five year projections revealed only a 0.4052 and 0.2389 P-value, which indicates a slight tendency of downward bias. The results are based on a sign test of unmatched pairs using budget to five year forecast spans from 1979 to 1996. The other forecast agencies, CBO and DRI, exhibited upward rather than a downward bias. Analysis of forecast mean error and dispersion show no notable differences between DoD, CBO, and DRI budget year forecasts. Forecasts for later years yield mixed results. CBO and DRI forecasts tend to exhibit less dispersion, but DoD tends to have smaller mean errors.

V. Conclusions and Recommendations

Interpretation

This chapter provides an interpretation of the results obtained in Chapter IV, possible explanations to these findings, recommended future research, and the application of these findings. DoD four and five year GNP/GDP IPD projections tend to predict lower inflation based on analysis of DoD, CBO, and DRI inflation estimates during the years 1979 to 1996. Overall, CBO and DRI were found to have the least dispersion, but to overestimate inflation on average over the one to five year forecast spans. The DoD forecasts had more dispersion but also had smaller mean errors. Since DoD forecasts are based on a small sample size of 18 observations, it's difficult to draw concrete statistical conclusions. Also, each forecasting agency can be expected to change their methodologies and specific objectives in the future as evidenced by the documented changes in the past. The historical forecasting record of the agencies evaluated today may not prevail into the future due to personnel changes and methodology adjustments. For example, all agencies adopted the chain-weighted methodology to forecast GDP IPD beginning in 1995 while the results of this analysis are based on the previously used fixed weighted methodology.

Possible Explanations

The relatively low inflation rate over the last decade and pressure to balance the Unified Federal Budget may encourage opportunistic DoD inflation estimates. Current

OMB budgetary requirements to report anticipated aggregate inflation rates based on GDP IPD forecasts derived by *Troika* might be unrealistic since these estimates reflect the Administration's policy objectives rather than scientific estimates. Also, military programs must compete for funding against other government programs that incorporate the OMB mandated rate, even when it is likely military acquisitions will experience higher than normal future inflation due to their unique nature and longer procurement cycles. Finally, past DoD acquisitions have experienced inflation rates that normally exceed the overall GDP rate for the entire U.S. economy.

Given that an inflation estimate, free from bias, should randomly under-forecast and over-forecast the actual inflation rate over time, the current practice of aggregate DoD inflation estimates not exceeding the OMB mandated rate seems to place a glass ceiling on military inflation estimates. This is partially demonstrated by the underestimation of inflation found in long-term DoD forecasts and the finding that one and two-year Naïve approach forecasts out-performed comparable DoD forecasts. The perceived short term benefit of lower defense budgets based on overly optimistic inflation forecasts actually increases the risk of long-term budget shortfalls funding major acquisition programs.

Future Research

1. Do OMB mandated forecasts of GDP IPD accurately measure inflation experienced by DoD non-pay and non-fuel programs? Further research is required to

investigate whether the long-standing assumption that DoD inflation can be estimated by GDP IPD is valid.

2. Further quantitative analysis is required to investigate downward bias in long term DoD projections. If downward bias is validated by additional DoD GDP IPD research, perhaps a Bias Adjustment Factor (BAF) or series of adjustments be applied to OMB mandated inflation rates to approximate the "best" of the other forecast agencies.

3. Further research is necessary to determine if the chain-weighted GDP IPD methodology adopted by DoD in 1997 to estimate inflation in Other Purchases more accurately predicts future inflation than the pre-existing fixed-weighted methodology.

4. An in depth analysis of the actual methodologies employed by the CBO and OMB to forecast inflation would further clarify the differences between each agency's forecast.

5. Further investigation is required to determine if a possible upward bias exists in the forecasts of the CBO and DRI based on a casual review of mean error over the last 18 years that was found to be as high as 2.05 in the DRI five-year forecast.

Application of Findings

This research indicates DoD long-term projections have a slight downward bias while DoD short-term and CBO and DRI forecasts have tended to overstate inflation. Accurate measurement of current inflation and improved forecasting techniques are critical to the integrity of defense programs since unexpected inflationary pressure can have a dramatic effect on overall program costs. Inflation in personnel and fuel

expenditures have been relatively stable while DoD non-fuel and non-pay expenditures, estimated by the GDP implicit price deflator, are subject to greater variability due to long production lead times. Improved understanding of potential bias in agency forecasts of the GDP implicit price deflator will improve the DoD's ability to anticipate inflation. Under estimates of future inflation by the DoD eventually leads to defense budget shortfalls, program stretch outs, and fewer purchases.

Appendix A: GNP/GDP Inflation Forecasts and Statistical Analysis

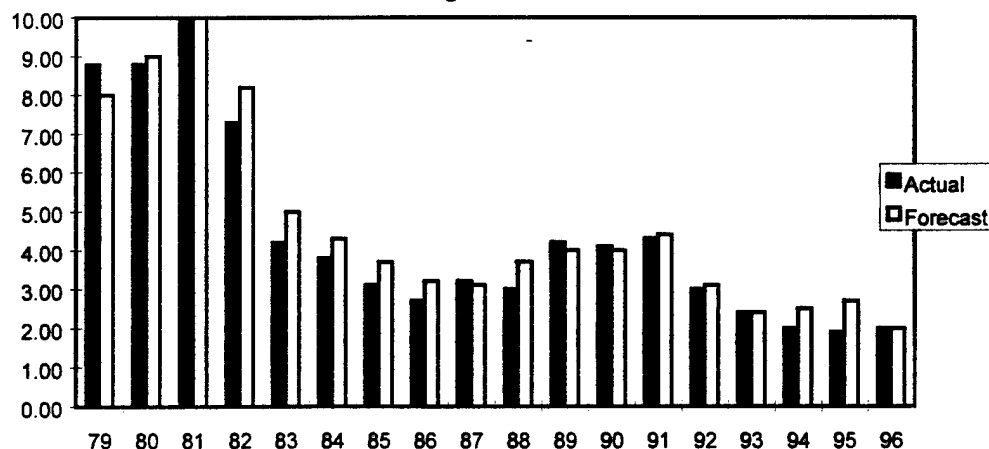
Introduction. This section provides the research charts which describe the years observed, actual inflation rates, forecast values, descriptive statistical analysis, and sign test results. The years analyzed include 1979 through 1996 with an “ * ” used to indicate values not available. The actual Gross National Product (Fiscal Years 1979-1991) and Gross Domestic Product (1992-1996) IPD (based on a fixed weighted methodology) actual values, DoD forecasts, and Naïve approach forecasts were obtained from the National Defense Budget Estimates for FY 1998 (1997), Table 10 (59). The CBO calendar year implicit deflator forecasts were obtained from Congressional Budget Office publications, Baseline Budget Projections (1978-1983) and The Economic and Budget Outlook: Fiscal Years (1984-1996). Data Resources, Incorporated forecasts were provided by the Economics Division, Secretary of the Air Force Directorate of Economics and Business Management (SAF/FMCEE). The forecast spans, current year through five years ahead, are listed by agency in the following order:

1. Department of Defense (DoD).....	64
2. Congressional Budget Office (CBO).....	70
3. Data Resources, Incorporated (DRI).....	76
4. Naive Approach	82

DoD Budget Year Inflation Forecast of GNP/GDP IPD

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	8.00	-	-0.80	0.80	0.64
80	8.80	9.00	+	0.20	0.20	0.04
81	10.00	10.00	=	0.00	0.00	0.00
82	7.30	8.20	+	0.90	0.90	0.81
83	4.20	5.00	+	0.80	0.80	0.64
84	3.80	4.30	+	0.50	0.50	0.25
85	3.10	3.70	+	0.60	0.60	0.36
86	2.70	3.20	+	0.50	0.50	0.25
87	3.20	3.10	-	-0.10	0.10	0.01
88	3.00	3.70	+	0.70	0.70	0.49
89	4.20	4.00	-	-0.20	0.20	0.04
90	4.10	4.00	-	-0.10	0.10	0.01
91	4.30	4.40	+	0.10	0.10	0.01
92	3.00	3.10	+	0.10	0.10	0.01
93	2.40	2.40	=	0.00	0.00	0.00
94	2.00	2.50	+	0.50	0.50	0.25
95	1.90	2.70	+	0.80	0.80	0.64
96	2.00	2.00	=	0.00	0.00	0.00
Total	78.8	83.3	18	4.50	6.90	4.45
Mean	4.38	4.63				
Mean Error	0.25				Sign Test	15
MAD	0.38				Under	4
RMSE	0.50				z-value	-2.07
Variance	0.25				p-value	0.9808

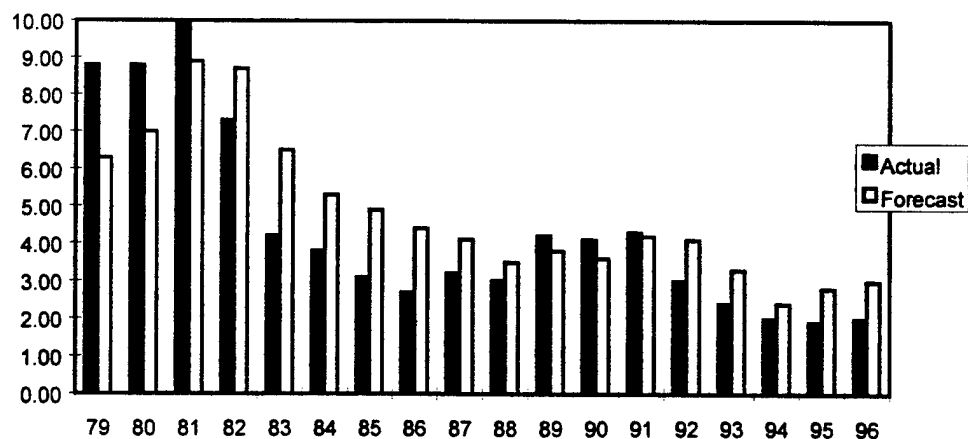
DoD Budget Year Estimates



DoD One Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	6.30	-	-2.50	2.50	6.25
80	8.80	7.00	-	-1.80	1.80	3.24
81	10.00	8.90	-	-1.10	1.10	1.21
82	7.30	8.70	+	1.40	1.40	1.96
83	4.20	6.50	+	2.30	2.30	5.29
84	3.80	5.30	+	1.50	1.50	2.25
85	3.10	4.90	+	1.80	1.80	3.24
86	2.70	4.40	+	1.70	1.70	2.89
87	3.20	4.10	+	0.90	0.90	0.81
88	3.00	3.50	+	0.50	0.50	0.25
89	4.20	3.80	-	-0.40	0.40	0.16
90	4.10	3.60	-	-0.50	0.50	0.25
91	4.30	4.20	-	-0.10	0.10	0.01
92	3.00	4.10	+	1.10	1.10	1.21
93	2.40	3.30	+	0.90	0.90	0.81
94	2.00	2.40	+	0.40	0.40	0.16
95	1.90	2.80	+	0.90	0.90	0.81
96	2.00	3.00	+	1.00	1.00	1.00
Total	78.8	86.8	18	8.00	20.80	31.80
Mean	4.38	4.82				
Mean Error	0.44				Sign Test	18
MAD	1.16				Under	6
RMSE	1.33				z-value	-1.65
Variance	1.77				p-value	0.9505

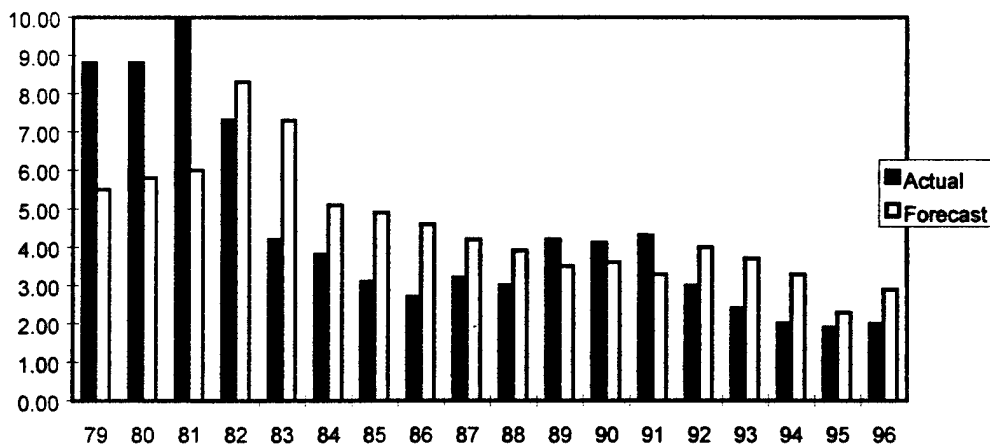
DoD One Year Estimates



DoD Two Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	5.50	-	-3.30	3.30	10.89
80	8.80	5.80	-	-3.00	3.00	9.00
81	10.00	6.00	-	-4.00	4.00	16.00
82	7.30	8.30	+	1.00	1.00	1.00
83	4.20	7.30	+	3.10	3.10	9.61
84	3.80	5.10	+	1.30	1.30	1.69
85	3.10	4.90	+	1.80	1.80	3.24
86	2.70	4.60	+	1.90	1.90	3.61
87	3.20	4.20	+	1.00	1.00	1.00
88	3.00	3.90	+	0.90	0.90	0.81
89	4.20	3.50	-	-0.70	0.70	0.49
90	4.10	3.60	-	-0.50	0.50	0.25
91	4.30	3.30	-	-1.00	1.00	1.00
92	3.00	4.00	+	1.00	1.00	1.00
93	2.40	3.70	+	1.30	1.30	1.69
94	2.00	3.30	+	1.30	1.30	1.69
95	1.90	2.30	+	0.40	0.40	0.16
96	2.00	2.90	+	0.90	0.90	0.81
Total	78.8	82.2	18	3.40	28.40	63.94
Mean	4.38	4.57				
Mean Error	0.19				Sign Test	18
MAD	1.58				Under	6
RMSE	1.88				z-value	-1.65
Variance	3.55				p-value	0.9505

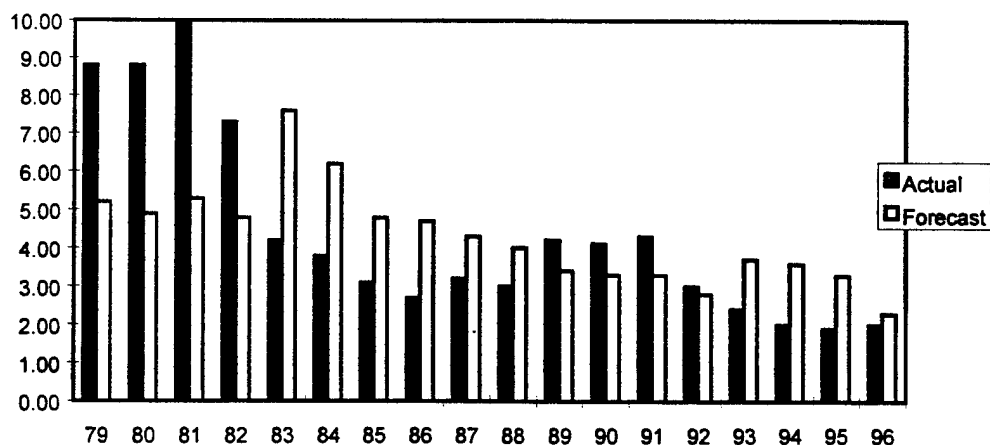
DoD Two Year Estimates



DoD Three Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	5.20	-	-3.60	3.60	12.96
80	8.80	4.90	-	-3.90	3.90	15.21
81	10.00	5.30	-	-4.70	4.70	22.09
82	7.30	4.80	-	-2.50	2.50	6.25
83	4.20	7.60	+	3.40	3.40	11.56
84	3.80	6.20	+	2.40	2.40	5.76
85	3.10	4.80	+	1.70	1.70	2.89
86	2.70	4.70	+	2.00	2.00	4.00
87	3.20	4.30	+	1.10	1.10	1.21
88	3.00	4.00	+	1.00	1.00	1.00
89	4.20	3.40	-	-0.80	0.80	0.64
90	4.10	3.30	-	-0.80	0.80	0.64
91	4.30	3.30	-	-1.00	1.00	1.00
92	3.00	2.80	-	-0.20	0.20	0.04
93	2.40	3.70	+	1.30	1.30	1.69
94	2.00	3.60	+	1.60	1.60	2.56
95	1.90	3.30	+	1.40	1.40	1.96
96	2.00	2.30	+	0.30	0.30	0.09
Total	78.8	77.5	18	-1.30	33.70	91.55
Mean	4.38	4.31				
Mean Error	-0.07				Sign Test	18
MAD	1.87				Under	8
RMSE	2.26				z-value	-0.71
Variance	5.09				p-value	0.7611

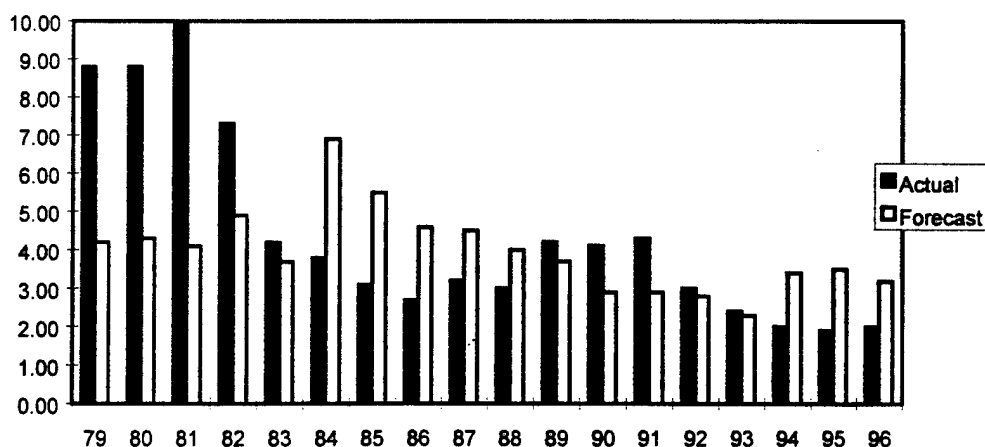
DoD Three Year Estimates



DoD Four Year Inflation Forecast of GNP/GDP IPD

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	4.20	-	-4.60	4.60	21.16
80	8.80	4.30	-	-4.50	4.50	20.25
81	10.00	4.10	-	-5.90	5.90	34.81
82	7.30	4.90	-	-2.40	2.40	5.76
83	4.20	3.70	-	-0.50	0.50	0.25
84	3.80	6.90	+	3.10	3.10	9.61
85	3.10	5.50	+	2.40	2.40	5.76
86	2.70	4.60	+	1.90	1.90	3.61
87	3.20	4.50	+	1.30	1.30	1.69
88	3.00	4.00	+	1.00	1.00	1.00
89	4.20	3.70	-	-0.50	0.50	0.25
90	4.10	2.90	-	-1.20	1.20	1.44
91	4.30	2.90	-	-1.40	1.40	1.96
92	3.00	2.80	-	-0.20	0.20	0.04
93	2.40	2.30	-	-0.10	0.10	0.01
94	2.00	3.40	+	1.40	1.40	1.96
95	1.90	3.50	+	1.60	1.60	2.56
96	2.00	3.20	+	1.20	1.20	1.44
Total	78.8	71.4	18	-7.40	35.20	113.56
Mean	4.38	3.97				
Mean Error	-0.41				Sign Test	18
MAD	1.96				Under	10
RMSE	2.51				z-value	0.24
Variance	6.31				p-value	0.4052

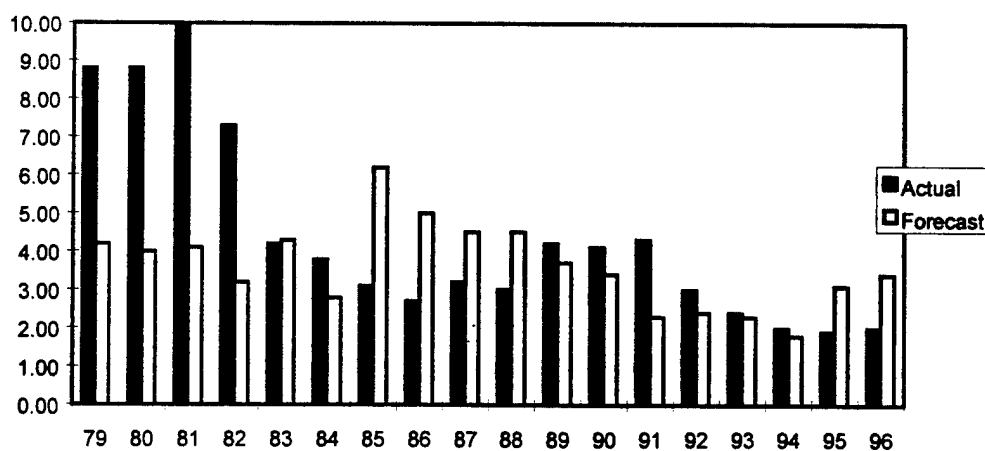
DoD Four Year Estiamtes



DoD Five Year Inflation Forecast of GNP/GDP IPD

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	4.20	-	-4.60	4.60	21.16
80	8.80	4.00	-	-4.80	4.80	23.04
81	10.00	4.10	-	-5.90	5.90	34.81
82	7.30	3.20	-	-4.10	4.10	16.81
83	4.20	4.30	+	0.10	0.10	0.01
84	3.80	2.80	-	-1.00	1.00	1.00
85	3.10	6.20	+	3.10	3.10	9.61
86	2.70	5.00	+	2.30	2.30	5.29
87	3.20	4.50	+	1.30	1.30	1.69
88	3.00	4.50	+	1.50	1.50	2.25
89	4.20	3.70	-	-0.50	0.50	0.25
90	4.10	3.40	-	-0.70	0.70	0.49
91	4.30	2.30	-	-2.00	2.00	4.00
92	3.00	2.40	-	-0.60	0.60	0.36
93	2.40	2.30	-	-0.10	0.10	0.01
94	2.00	1.80	-	-0.20	0.20	0.04
95	1.90	3.10	+	1.20	1.20	1.44
96	2.00	3.40	+	1.40	1.40	1.96
Total	78.8	65.2	18	-13.60	35.40	124.22
Mean	4.38	3.62				
Mean Error	-0.76				Sign Test	18
MAD	1.97				Under	11
RMSE	2.63				z-value	0.71
Variance	6.90				p-value	0.2389

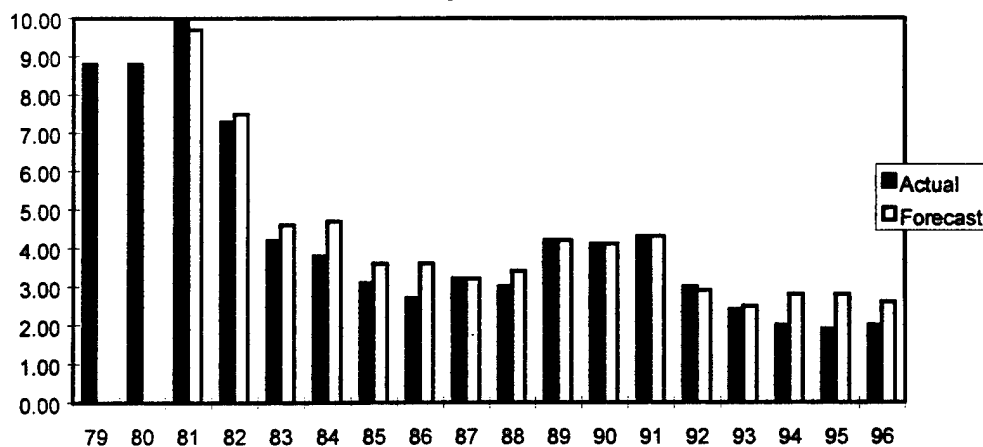
DoD Five Year Estimates



CBO Budget Year Inflation Forecast of GNP/GDP

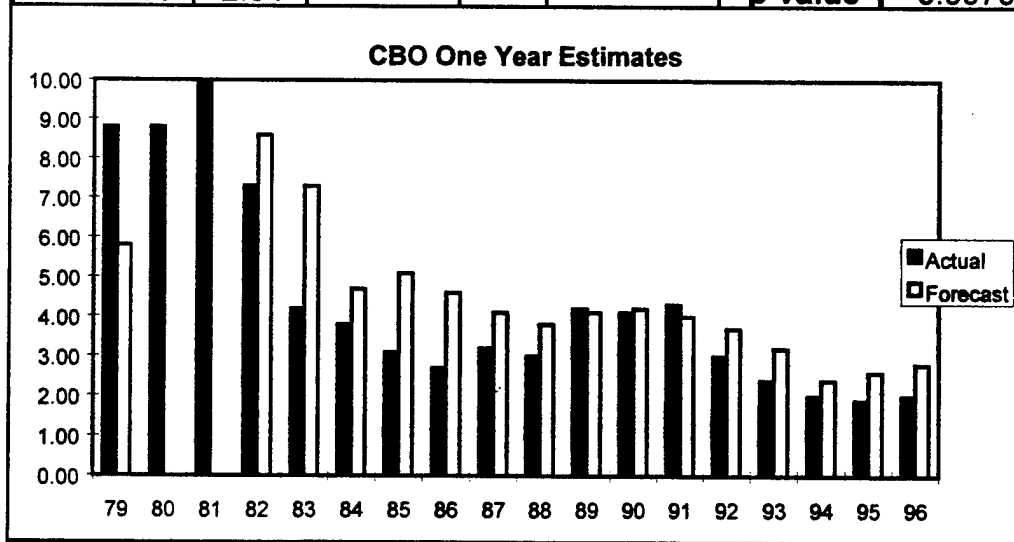
Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	9.70	-	-0.30	0.30	0.09
82	7.30	7.50	+	0.20	0.20	0.04
83	4.20	4.60	+	0.40	0.40	0.16
84	3.80	4.70	+	0.90	0.90	0.81
85	3.10	3.60	+	0.50	0.50	0.25
86	2.70	3.60	+	0.90	0.90	0.81
87	3.20	3.20	=	0.00	0.00	0.00
88	3.00	3.40	+	0.40	0.40	0.16
89	4.20	4.20	=	0.00	0.00	0.00
90	4.10	4.10	=	0.00	0.00	0.00
91	4.30	4.30	=	0.00	0.00	0.00
92	3.00	2.90	-	-0.10	0.10	0.01
93	2.40	2.50	+	0.10	0.10	0.01
94	2.00	2.80	+	0.80	0.80	0.64
95	1.90	2.80	+	0.90	0.90	0.81
96	2.00	2.60	+	0.60	0.60	0.36
Total	78.8	66.5	16	5.30	6.10	4.15
Mean	4.38	4.16				
Mean Error	0.33				Sign Test	12
MAD	0.38				Under	2
RMSE	0.51				z-value	-2.60
Variance	0.26				p-value	0.9953

CBO Budget Year Estimates



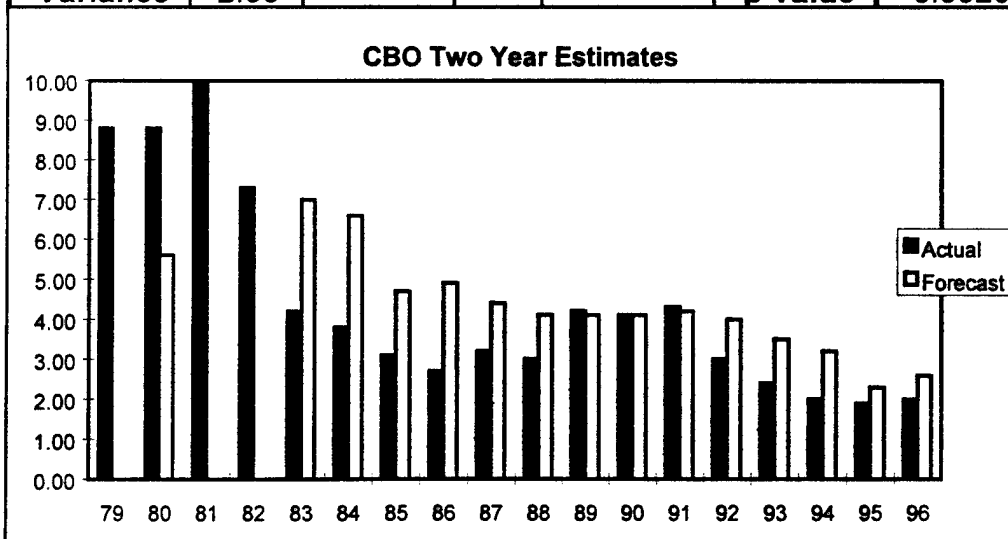
CBO One Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	5.81	-	-2.99	2.99	8.94
80	8.80	*				
81	10.00	*				
82	7.30	8.60	+	1.30	1.30	1.69
83	4.20	7.30	+	3.10	3.10	9.61
84	3.80	4.70	+	0.90	0.90	0.81
85	3.10	5.10	+	2.00	2.00	4.00
86	2.70	4.60	+	1.90	1.90	3.61
87	3.20	4.10	+	0.90	0.90	0.81
88	3.00	3.80	+	0.80	0.80	0.64
89	4.20	4.10	-	-0.10	0.10	0.01
90	4.10	4.20	+	0.10	0.10	0.01
91	4.30	4.00	-	-0.30	0.30	0.09
92	3.00	3.70	+	0.70	0.70	0.49
93	2.40	3.20	+	0.80	0.80	0.64
94	2.00	2.40	+	0.40	0.40	0.16
95	1.90	2.60	+	0.70	0.70	0.49
96	2.00	2.80	+	0.80	0.80	0.64
Total	78.8	71.01	16	11.01	17.79	32.64
Mean	4.38	4.44				
Mean Error	0.69				Sign Test	16
MAD	1.11				Under	3
RMSE	1.43				z-value	-2.75
Variance	2.04				p-value	0.9970



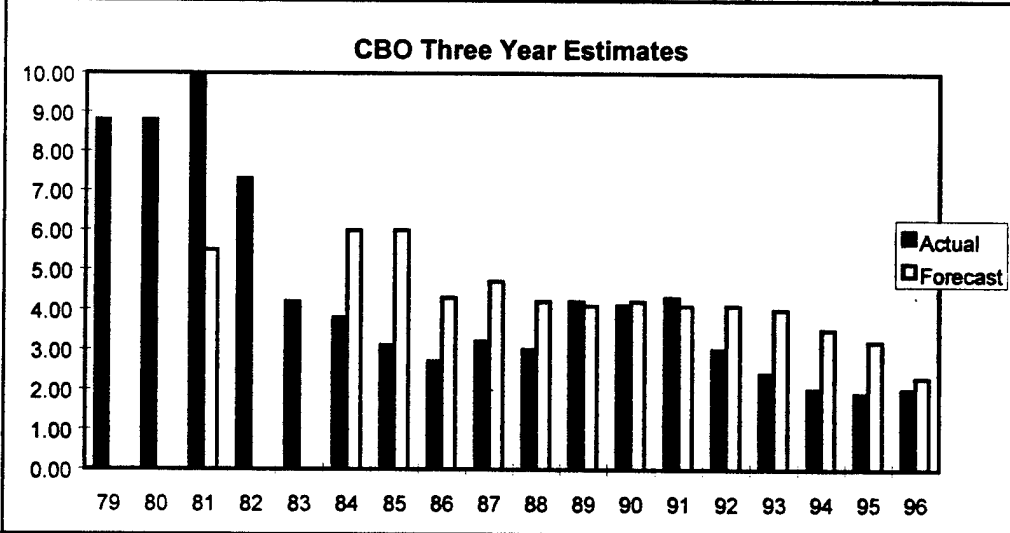
CBO Two Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	5.60	-	-3.20	3.20	10.24
81	10.00	*				
82	7.30	*				
83	4.20	7.00	+	2.80	2.80	7.84
84	3.80	6.60	+	2.80	2.80	7.84
85	3.10	4.70	+	1.60	1.60	2.56
86	2.70	4.90	+	2.20	2.20	4.84
87	3.20	4.40	+	1.20	1.20	1.44
88	3.00	4.10	+	1.10	1.10	1.21
89	4.20	4.10	-	-0.10	0.10	0.01
90	4.10	4.10	=	0.00	0.00	0.00
91	4.30	4.20	-	-0.10	0.10	0.01
92	3.00	4.00	+	1.00	1.00	1.00
93	2.40	3.50	+	1.10	1.10	1.21
94	2.00	3.20	+	1.20	1.20	1.44
95	1.90	2.30	+	0.40	0.40	0.16
96	2.00	2.60	+	0.60	0.60	0.36
Total	78.8	65.3	15	12.60	19.40	40.16
Mean	4.38	4.35				
Mean Error	0.84				Sign Test	14
MAD	1.29				Under	3
RMSE	1.64				z-value	-2.41
Variance	2.68				p-value	0.9920



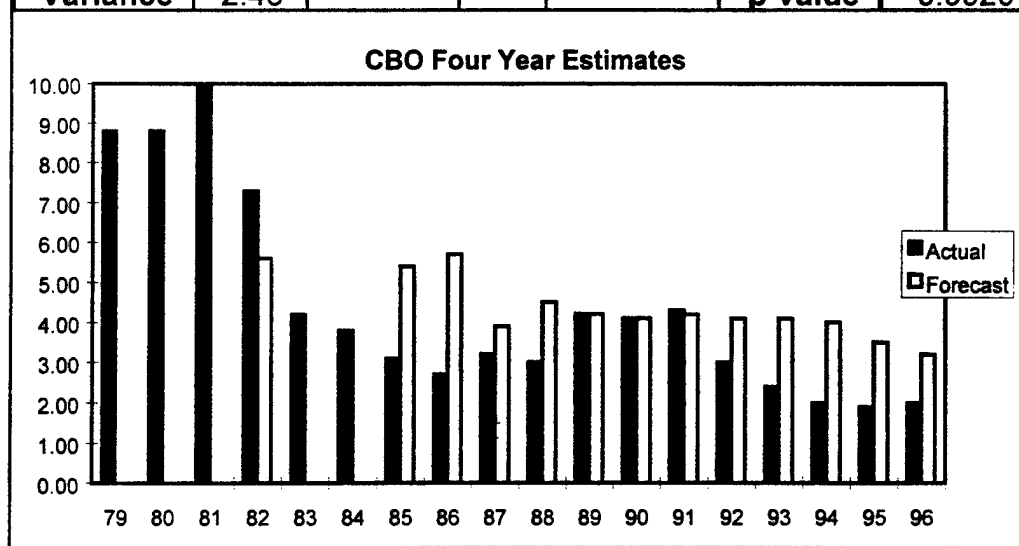
CBO Three Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	5.50	-	-4.50	4.50	20.25
82	7.30	*				
83	4.20	*				
84	3.80	6.00	+	2.20	2.20	4.84
85	3.10	6.00	+	2.90	2.90	8.41
86	2.70	4.30	+	1.60	1.60	2.56
87	3.20	4.70	+	1.50	1.50	2.25
88	3.00	4.20	+	1.20	1.20	1.44
89	4.20	4.10	-	-0.10	0.10	0.01
90	4.10	4.20	+	0.10	0.10	0.01
91	4.30	4.10	-	-0.20	0.20	0.04
92	3.00	4.10	+	1.10	1.10	1.21
93	2.40	4.00	+	1.60	1.60	2.56
94	2.00	3.50	+	1.50	1.50	2.25
95	1.90	3.20	+	1.30	1.30	1.69
96	2.00	2.30	+	0.30	0.30	0.09
Total	78.8	60.2	14	10.50	20.10	47.61
Mean	4.38	4.30				
Mean Error	0.75				Sign Test	14
MAD	1.44				Under	3
RMSE	1.84				z-value	-2.41
Variance	3.40				p-value	0.9920



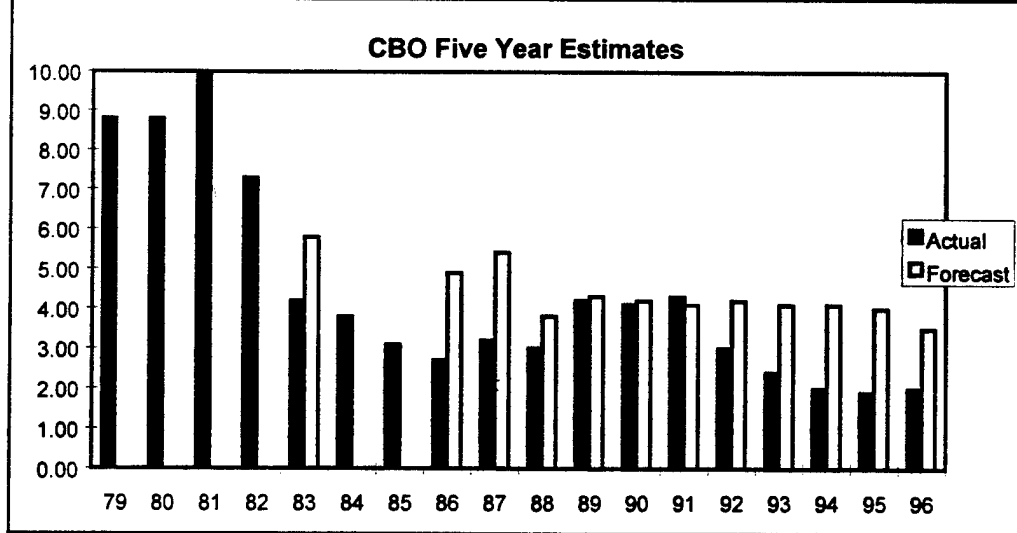
CBO Four Year Inflation Forecasts of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	*				
82	7.30	5.60	-	-1.70	1.70	2.89
83	4.20	*				
84	3.80	*				
85	3.10	5.40	+	2.30	2.30	5.29
86	2.70	5.70	+	3.00	3.00	9.00
87	3.20	3.90	+	0.70	0.70	0.49
88	3.00	4.50	+	1.50	1.50	2.25
89	4.20	4.20	=	0.00	0.00	0.00
90	4.10	4.10	=	0.00	0.00	0.00
91	4.30	4.20	-	-0.10	0.10	0.01
92	3.00	4.10	+	1.10	1.10	1.21
93	2.40	4.10	+	1.70	1.70	2.89
94	2.00	4.00	+	2.00	2.00	4.00
95	1.90	3.50	+	1.60	1.60	2.56
96	2.00	3.20	+	1.20	1.20	1.44
Total	78.8	56.5	13	13.30	16.90	32.03
Mean	4.38	4.35				
Mean Error	1.02				Sign Test	11
MAD	1.30				Under	2
RMSE	1.57				z-value	-2.41
Variance	2.46				p-value	0.9920



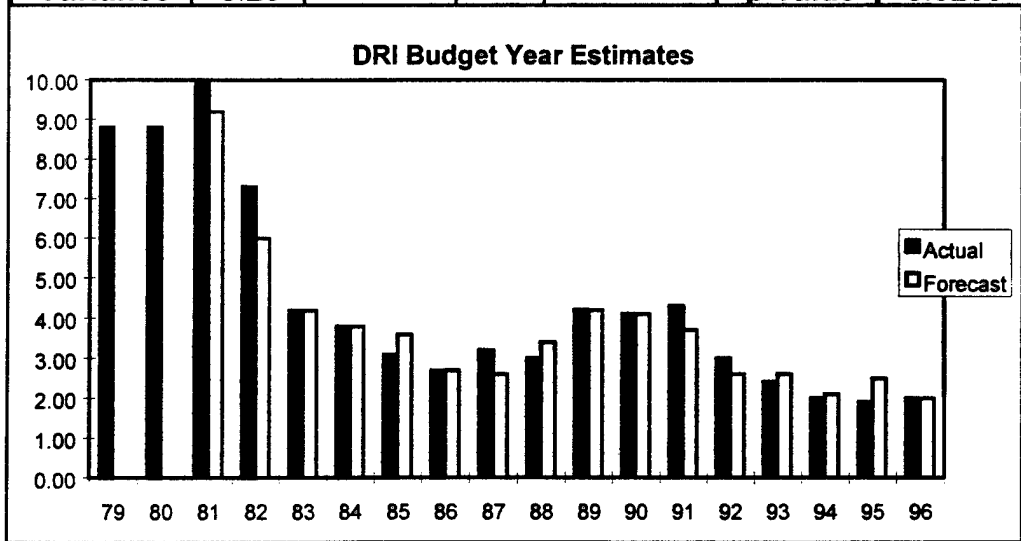
CBO Five Year Inflation Forecasts of GNP/GDP IPD

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	*				
82	7.30	*				
83	4.20	5.80	+	1.60	1.60	2.56
84	3.80	*				
85	3.10	*				
86	2.70	4.90	+	2.20	2.20	4.84
87	3.20	5.40	+	2.20	2.20	4.84
88	3.00	3.80	+	0.80	0.80	0.64
89	4.20	4.30	+	0.10	0.10	0.01
90	4.10	4.20	+	0.10	0.10	0.01
91	4.30	4.10	-	-0.20	0.20	0.04
92	3.00	4.20	+	1.20	1.20	1.44
93	2.40	4.10	+	1.70	1.70	2.89
94	2.00	4.10	+	2.10	2.10	4.41
95	1.90	4.00	+	2.10	2.10	4.41
96	2.00	3.50	+	1.50	1.50	2.25
Total	78.8	52.4	12	15.40	15.80	28.34
Mean	4.38	4.37				
Mean Error	1.28				Sign Test	12
MAD	1.32				Under	1
RMSE	1.54				z-value	-3.18
Variance	2.36				p-value	0.9993



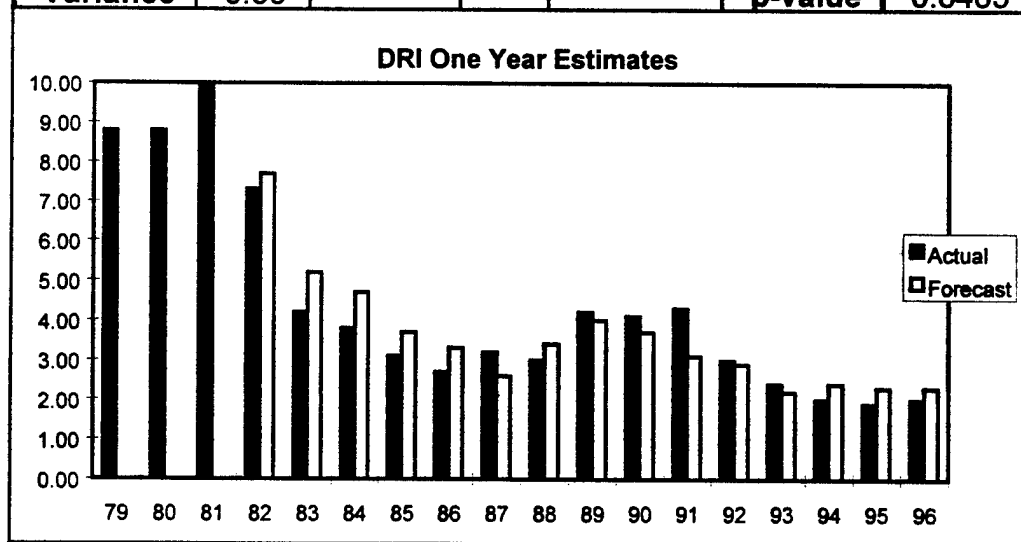
DRI Budget Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	9.20	-	-0.80	0.80	0.64
82	7.30	6.00	-	-1.30	1.30	1.69
83	4.20	4.20	=	0.00	0.00	0.00
84	3.80	3.80	=	0.00	0.00	0.00
85	3.10	3.60	+	0.50	0.50	0.25
86	2.70	2.70	=	0.00	0.00	0.00
87	3.20	2.60	-	-0.60	0.60	0.36
88	3.00	3.40	+	0.40	0.40	0.16
89	4.20	4.20	=	0.00	0.00	0.00
90	4.10	4.10	=	0.00	0.00	0.00
91	4.30	3.70	-	-0.60	0.60	0.36
92	3.00	2.60	-	-0.40	0.40	0.16
93	2.40	2.60	+	0.20	0.20	0.04
94	2.00	2.10	+	0.10	0.10	0.01
95	1.90	2.50	+	0.60	0.60	0.36
96	2.00	2.00	=	0.00	0.00	0.00
Total	78.8	59.3	16	-1.90	5.50	4.03
Mean	4.38	3.71				
Mean Error	-0.12				Sign Test	10
MAD	0.34				Under	5
RMSE	0.50				z-value	-0.32
Variance	0.25				p-value	0.6255



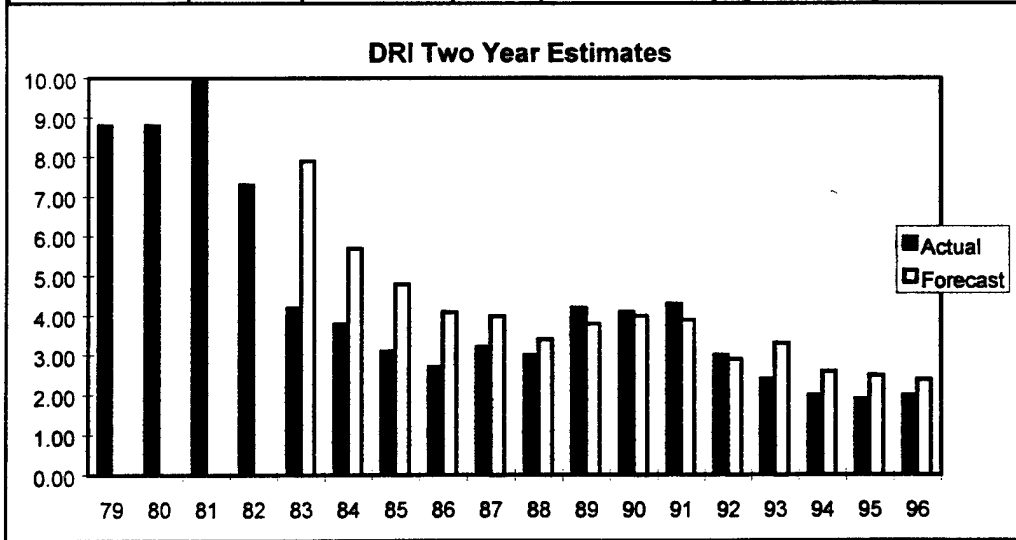
DRI One Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	*				
82	7.30	7.70	+	0.40	0.40	0.16
83	4.20	5.20	+	1.00	1.00	1.00
84	3.80	4.70	+	0.90	0.90	0.81
85	3.10	3.70	+	0.60	0.60	0.36
86	2.70	3.30	+	0.60	0.60	0.36
87	3.20	2.60	-	-0.60	0.60	0.36
88	3.00	3.40	+	0.40	0.40	0.16
89	4.20	4.00	-	-0.20	0.20	0.04
90	4.10	3.70	-	-0.40	0.40	0.16
91	4.30	3.10	-	-1.20	1.20	1.44
92	3.00	2.90	-	-0.10	0.10	0.01
93	2.40	2.20	-	-0.20	0.20	0.04
94	2.00	2.40	+	0.40	0.40	0.16
95	1.90	2.30	+	0.40	0.40	0.16
96	2.00	2.30	+	0.30	0.30	0.09
Total	78.8	53.5	15	2.30	7.70	5.31
Mean	4.38	3.57				
Mean Error	0.15				Sign Test	15
MAD	0.51				Under	6
RMSE	0.59				z-value	-1.03
Variance	0.35				p-value	0.8485



DRI Two Year Inflation Forecast of GNP/GDP

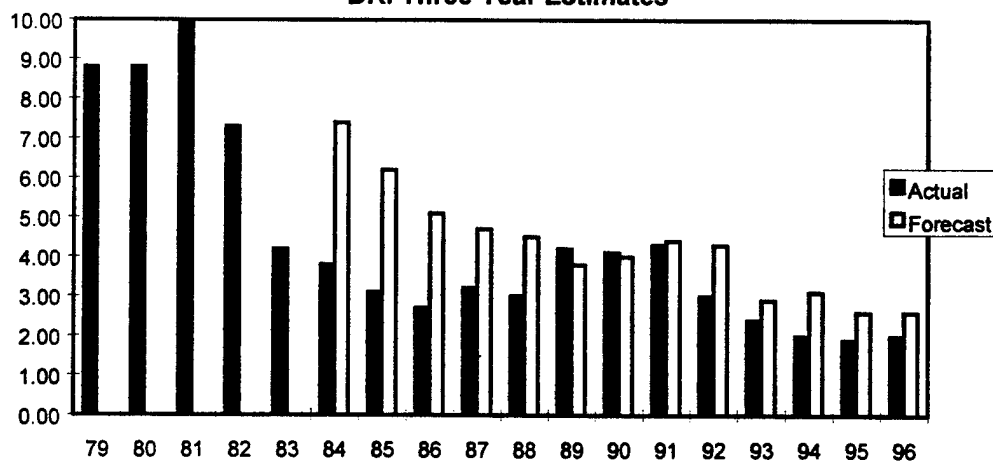
Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	*				
82	7.30	*				
83	4.20	7.90	+	3.70	3.70	13.69
84	3.80	5.70	+	1.90	1.90	3.61
85	3.10	4.80	+	1.70	1.70	2.89
86	2.70	4.10	+	1.40	1.40	1.96
87	3.20	4.00	+	0.80	0.80	0.64
88	3.00	3.40	+	0.40	0.40	0.16
89	4.20	3.80	-	-0.40	0.40	0.16
90	4.10	4.00	-	-0.10	0.10	0.01
91	4.30	3.90	-	-0.40	0.40	0.16
92	3.00	2.90	-	-0.10	0.10	0.01
93	2.40	3.30	+	0.90	0.90	0.81
94	2.00	2.60	+	0.60	0.60	0.36
95	1.90	2.50	+	0.60	0.60	0.36
96	2.00	2.40	+	0.40	0.40	0.16
Total	78.8	55.3	14	11.40	13.40	24.98
Mean	4.38	3.95				
Mean Error	0.81				Sign Test	14
MAD	0.96				Under	4
RMSE	1.34				z-value	-1.87
Variance	1.78				p-value	0.9693



DRI Three Year Inflation Forecast of GNP/GDP

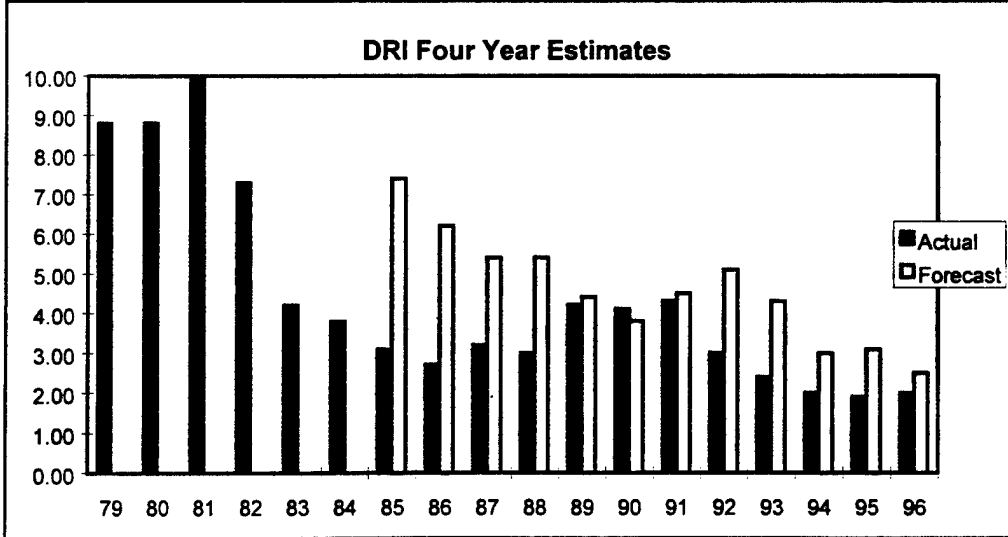
Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	*				
82	7.30	*				
83	4.20	*				
84	3.80	7.40	+	3.60	3.60	12.96
85	3.10	6.20	+	3.10	3.10	9.61
86	2.70	5.10	+	2.40	2.40	5.76
87	3.20	4.70	+	1.50	1.50	2.25
88	3.00	4.50	+	1.50	1.50	2.25
89	4.20	3.80	-	-0.40	0.40	0.16
90	4.10	4.00	-	-0.10	0.10	0.01
91	4.30	4.40	+	0.10	0.10	0.01
92	3.00	4.30	+	1.30	1.30	1.69
93	2.40	2.90	+	0.50	0.50	0.25
94	2.00	3.10	+	1.10	1.10	1.21
95	1.90	2.60	+	0.70	0.70	0.49
96	2.00	2.60	+	0.60	0.60	0.36
Total	78.8	55.6	13	15.90	16.90	37.01
Mean	4.38	4.28				
Mean Error	1.22				Sign Test	13
MAD	1.30				Under	2
RMSE	1.69				z-value	-2.77
Variance	2.85				p-value	0.9972

DRI Three Year Estimates



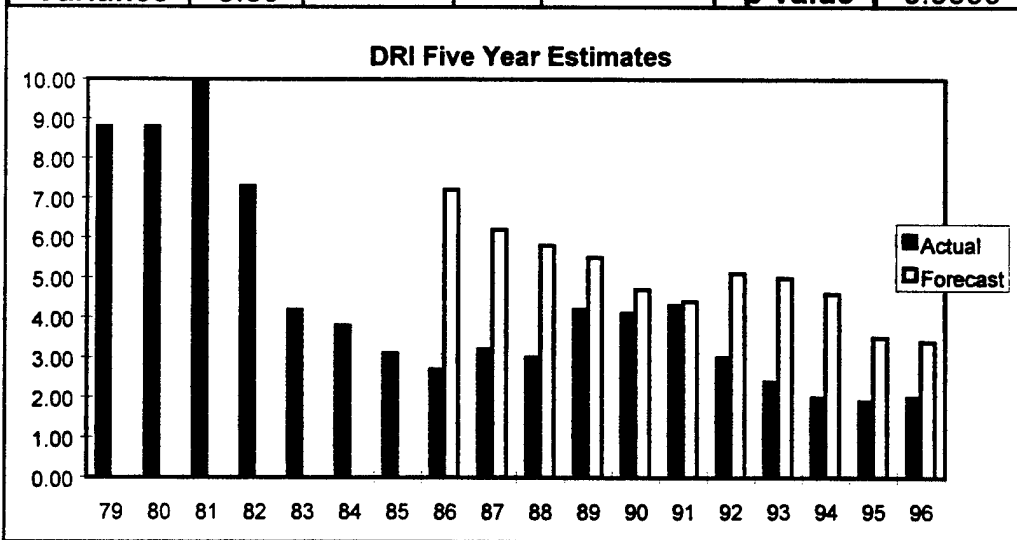
DRI Four Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	*				
82	7.30	*				
83	4.20	*				
84	3.80	*				
85	3.10	7.40	+	4.30	4.30	18.49
86	2.70	6.20	+	3.50	3.50	12.25
87	3.20	5.40	+	2.20	2.20	4.84
88	3.00	5.40	+	2.40	2.40	5.76
89	4.20	4.40	+	0.20	0.20	0.04
90	4.10	3.80	-	-0.30	0.30	0.09
91	4.30	4.50	+	0.20	0.20	0.04
92	3.00	5.10	+	2.10	2.10	4.41
93	2.40	4.30	+	1.90	1.90	3.61
94	2.00	3.00	+	1.00	1.00	1.00
95	1.90	3.10	+	1.20	1.20	1.44
96	2.00	2.50	+	0.50	0.50	0.25
Total	78.8	55.1	12	19.20	19.80	52.22
Mean	4.38	4.59				
Mean Error	1.60				Sign Test	12
MAD	1.65				Under	1
RMSE	2.09				z-value	-3.18
Variance	4.35				p-value	0.9993



DRI Five Year Inflation Forecast of GNP/GDP

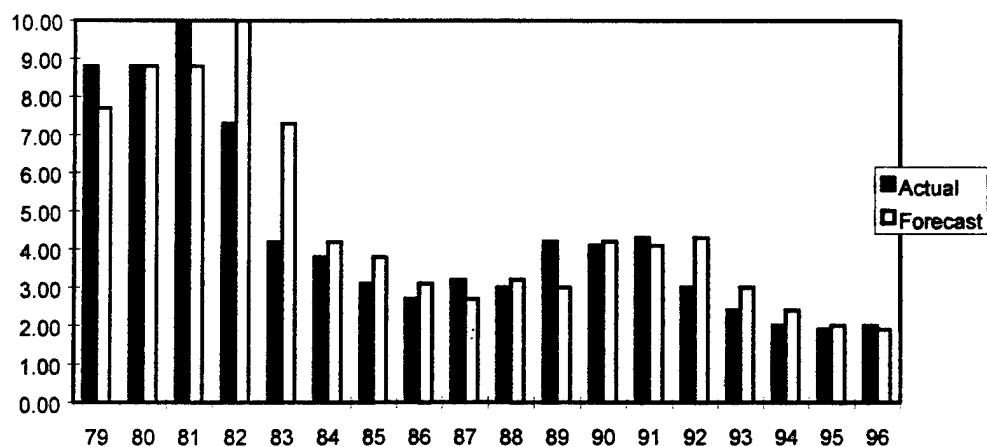
Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	*				
80	8.80	*				
81	10.00	*				
82	7.30	*				
83	4.20	*				
84	3.80	*				
85	3.10	*				
86	2.70	7.20	+	4.50	4.50	20.25
87	3.20	6.20	+	3.00	3.00	9.00
88	3.00	5.80	+	2.80	2.80	7.84
89	4.20	5.50	+	1.30	1.30	1.69
90	4.10	4.70	+	0.60	0.60	0.36
91	4.30	4.40	+	0.10	0.10	0.01
92	3.00	5.10	+	2.10	2.10	4.41
93	2.40	5.00	+	2.60	2.60	6.76
94	2.00	4.60	+	2.60	2.60	6.76
95	1.90	3.50	+	1.60	1.60	2.56
96	2.00	3.40	+	1.40	1.40	1.96
Total	78.8	55.4	11	22.60	22.60	61.60
Mean	4.38	5.04				
Mean Error	2.05				Sign Test	11
MAD	2.05				Under	0
RMSE	2.37				z-value	-3.62
Variance	5.60				p-value	0.9999



Naïve One Year Inflation Forecast of GNP/GDP

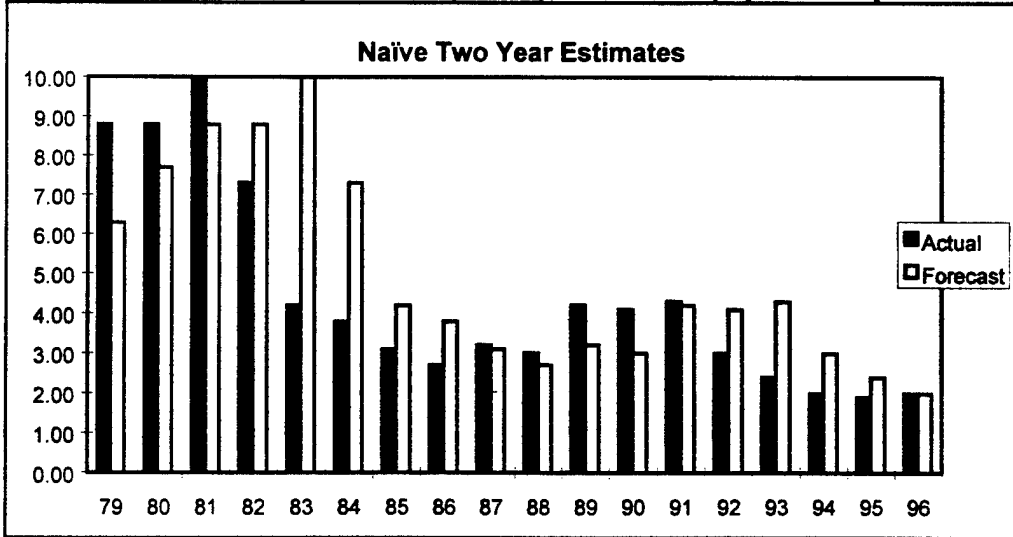
Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	7.70	-	-1.10	1.10	1.21
80	8.80	8.80	=	0.00	0.00	0.00
81	10.00	8.80	-	-1.20	1.20	1.44
82	7.30	10.00	+	2.70	2.70	7.29
83	4.20	7.30	+	3.10	3.10	9.61
84	3.80	4.20	+	0.40	0.40	0.16
85	3.10	3.80	+	0.70	0.70	0.49
86	2.70	3.10	+	0.40	0.40	0.16
87	3.20	2.70	-	-0.50	0.50	0.25
88	3.00	3.20	+	0.20	0.20	0.04
89	4.20	3.00	-	-1.20	1.20	1.44
90	4.10	4.20	+	0.10	0.10	0.01
91	4.30	4.10	-	-0.20	0.20	0.04
92	3.00	4.30	+	1.30	1.30	1.69
93	2.40	3.00	+	0.60	0.60	0.36
94	2.00	2.40	+	0.40	0.40	0.16
95	1.90	2.00	+	0.10	0.10	0.01
96	2.00	1.90	-	-0.10	0.10	0.01
Total	78.8	84.5	18	5.70	14.30	24.37
Mean	4.38	4.69				
Mean Error	0.32				Sign Test	17
MAD	0.79				Under	6
RMSE	1.16				z-value	-1.46
Variance	1.35				p-value	0.9279

Naïve One Year Estimates



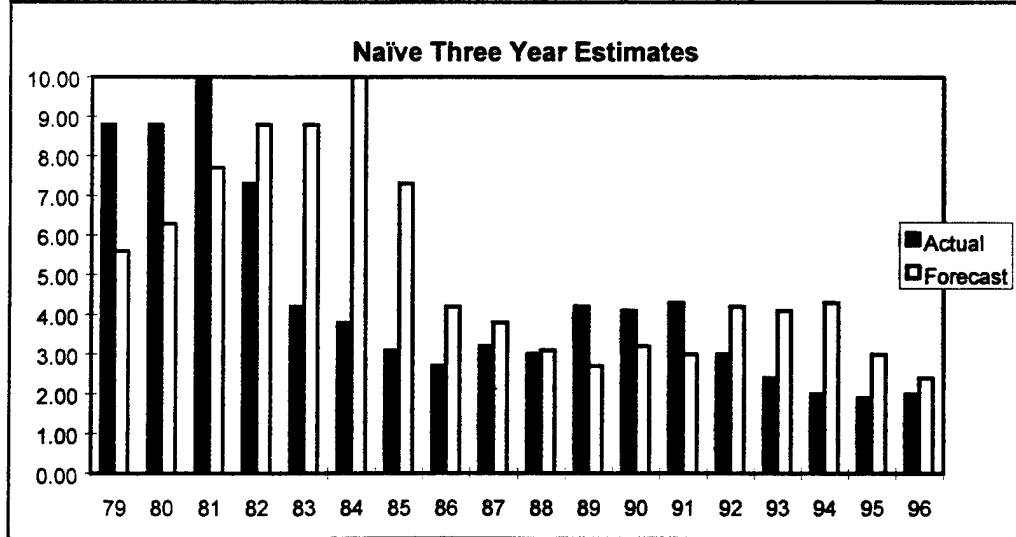
Naïve Two Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	6.30	-	-2.50	2.50	6.25
80	8.80	7.70	-	-1.10	1.10	1.21
81	10.00	8.80	-	-1.20	1.20	1.44
82	7.30	8.80	+	1.50	1.50	2.25
83	4.20	10.00	+	5.80	5.80	33.64
84	3.80	7.30	+	3.50	3.50	12.25
85	3.10	4.20	+	1.10	1.10	1.21
86	2.70	3.80	+	1.10	1.10	1.21
87	3.20	3.10	-	-0.10	0.10	0.01
88	3.00	2.70	-	-0.30	0.30	0.09
89	4.20	3.20	-	-1.00	1.00	1.00
90	4.10	3.00	-	-1.10	1.10	1.21
91	4.30	4.20	-	-0.10	0.10	0.01
92	3.00	4.10	+	1.10	1.10	1.21
93	2.40	4.30	+	1.90	1.90	3.61
94	2.00	3.00	+	1.00	1.00	1.00
95	1.90	2.40	+	0.50	0.50	0.25
96	2.00	2.00	=	0.00	0.00	0.00
Total	78.8	88.9	18	10.10	24.90	67.85
Mean	4.38	4.94				
Mean Error	0.56				Sign Test	17
MAD	1.38				Under	8
RMSE	1.94				z-value	-0.49
Variance	3.77				p-value	0.6879



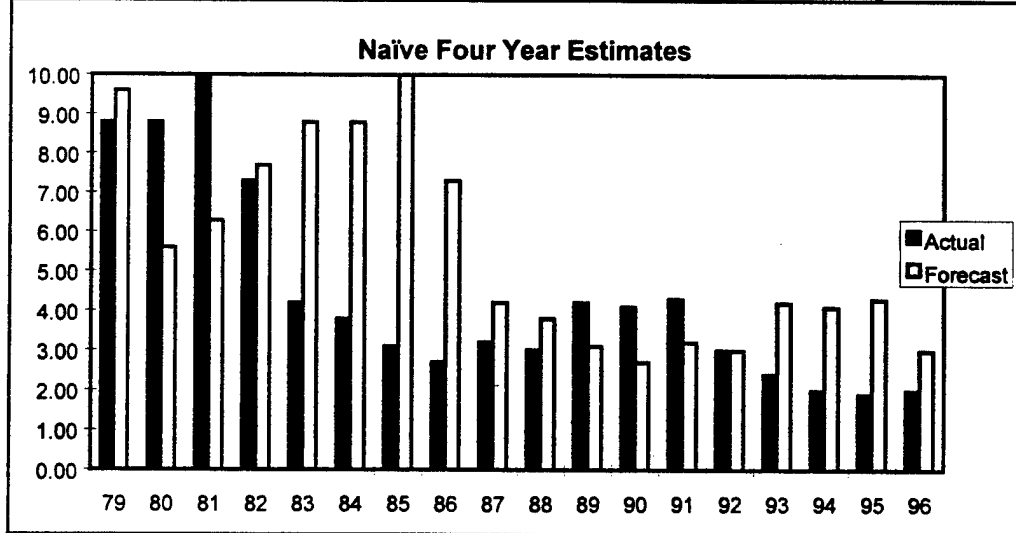
Naïve Three Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	5.60	-	-3.20	3.20	10.24
80	8.80	6.30	-	-2.50	2.50	6.25
81	10.00	7.70	-	-2.30	2.30	5.29
82	7.30	8.80	+	1.50	1.50	2.25
83	4.20	8.80	+	4.60	4.60	21.16
84	3.80	10.00	+	6.20	6.20	38.44
85	3.10	7.30	+	4.20	4.20	17.64
86	2.70	4.20	+	1.50	1.50	2.25
87	3.20	3.80	+	0.60	0.60	0.36
88	3.00	3.10	+	0.10	0.10	0.01
89	4.20	2.70	-	-1.50	1.50	2.25
90	4.10	3.20	-	-0.90	0.90	0.81
91	4.30	3.00	-	-1.30	1.30	1.69
92	3.00	4.20	+	1.20	1.20	1.44
93	2.40	4.10	+	1.70	1.70	2.89
94	2.00	4.30	+	2.30	2.30	5.29
95	1.90	3.00	+	1.10	1.10	1.21
96	2.00	2.40	+	0.40	0.40	0.16
Total	78.8	92.5	18	13.70	37.10	119.63
Mean	4.38	5.14				
Mean Error	0.76				Sign Test	18
MAD	2.06				Under	6
RMSE	2.58				z-value	-1.65
Variance	6.65				p-value	0.9505



Naïve Four Year Inflation Forecast of GNP/GDP

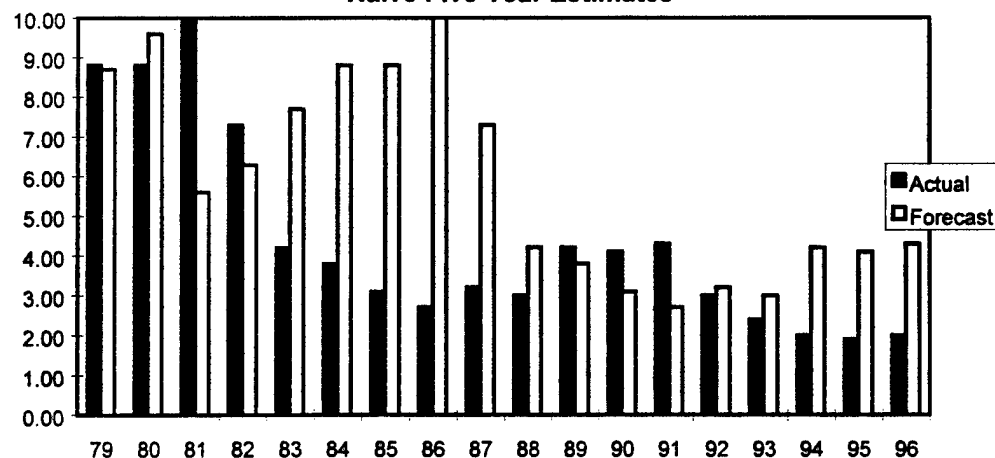
Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	9.60	+	0.80	0.80	0.64
80	8.80	5.60	-	-3.20	3.20	10.24
81	10.00	6.30	-	-3.70	3.70	13.69
82	7.30	7.70	+	0.40	0.40	0.16
83	4.20	8.80	+	4.60	4.60	21.16
84	3.80	8.80	+	5.00	5.00	25.00
85	3.10	10.00	+	6.90	6.90	47.61
86	2.70	7.30	+	4.60	4.60	21.16
87	3.20	4.20	+	1.00	1.00	1.00
88	3.00	3.80	+	0.80	0.80	0.64
89	4.20	3.10	-	-1.10	1.10	1.21
90	4.10	2.70	-	-1.40	1.40	1.96
91	4.30	3.20	-	-1.10	1.10	1.21
92	3.00	3.00	=	0.00	0.00	0.00
93	2.40	4.20	+	1.80	1.80	3.24
94	2.00	4.10	+	2.10	2.10	4.41
95	1.90	4.30	+	2.40	2.40	5.76
96	2.00	3.00	+	1.00	1.00	1.00
Total	78.8	99.7	18	20.90	41.90	160.09
Mean	4.38	5.54				
Mean Error	1.16				Sign Test	17
MAD	2.33				Under	5
RMSE	2.98				z-value	-1.94
Variance	8.89				p-value	0.9738



Naïve Five Year Inflation Forecast of GNP/GDP

Year	Actual	Forecast	Sign Test	Difference	Deviation	Squared Error
79	8.80	8.70	-	-0.10	0.10	0.01
80	8.80	9.60	+	0.80	0.80	0.64
81	10.00	5.60	-	-4.40	4.40	19.36
82	7.30	6.30	-	-1.00	1.00	1.00
83	4.20	7.70	+	3.50	3.50	12.25
84	3.80	8.80	+	5.00	5.00	25.00
85	3.10	8.80	+	5.70	5.70	32.49
86	2.70	10.00	+	7.30	7.30	53.29
87	3.20	7.30	+	4.10	4.10	16.81
88	3.00	4.20	+	1.20	1.20	1.44
89	4.20	3.80	-	-0.40	0.40	0.16
90	4.10	3.10	-	-1.00	1.00	1.00
91	4.30	2.70	-	-1.60	1.60	2.56
92	3.00	3.20	+	0.20	0.20	0.04
93	2.40	3.00	+	0.60	0.60	0.36
94	2.00	4.20	+	2.20	2.20	4.84
95	1.90	4.10	+	2.20	2.20	4.84
96	2.00	4.30	+	2.30	2.30	5.29
Total	78.8	105.4	18	26.60	43.60	181.38
Mean	4.38	5.86				
Mean Error	1.48				Sign Test	18
MAD	2.42				Under	6
RMSE	3.17				z-value	-1.65
Variance	10.08				p-value	0.9505

Naïve Five Year Estimates



Appendix B: Glossary of Acronyms and Terms

This Appendix contains the official definition of U.S. Government and Department of Defense terms which were extracted from the following publications: National Defense Budget Estimates for 1998 (1997), The Economic and Budget Outlook: Fiscal Years 1997-2006 (1996), and Air Force Instruction 65-502.

Appropriation. An act of Congress that enables Federal Agencies to spend money for specific purposes.

Authorization. An act of Congress that establishes or continues a federal program or agency and sets forth guidelines to which it must adhere.

Base Year. A point of reference that represents a fixed price level, usually defined as the fiscal year when a program was initially funded. Expressing program costs in a specified base year is the same as expressing those costs in constant year dollars of the same year.

Budget Authority. The authority to incur legally binding obligations of the Government which will result in immediate or future outlays. Also the value of new obligations (enacted appropriations) that the federal government is authorized to incur to include some obligations met in later years.

Business Cycle. Fluctuations in overall business activity accompanied by swings in the unemployment rate, interest rates and profits. Over a business cycle, real activity rises to a peak, then falls until it reaches its trough, whereupon it starts to rise again, defining a new cycle. Business cycles are irregular, varying in frequency, magnitude, and duration (CBO).

Chain-Type GDP Price Index. An overall measure of the price level in which the calculation of the change in prices uses the composition of output in adjoining years. This price index is currently set to equal one in 1992. Because this measure uses the composition of output in adjoining years, it is a more accurate measure of the way in which price change affects economic welfare than either the GDP IPD or the fixed-weighted GDP price index (CBO).

Congressional Budget Office (CBO). Provides assistance to Congress in fulfilling its responsibilities to ensure effective congressional control over the budget process, to determine each year the appropriate level of Federal revenues and expenditures, and to establish national budget priorities.

Constant-Year Dollars (Real Dollars). Reflects the value or purchasing power of a dollar in any specific year, which may or may not be the base year.

Constant-year dollars do not contain any adjustments for inflation that occurred or is forecast to occur outside the base year. Constant-year dollars are not influenced by outlay profiles (expenditure patterns).

Consumer Price Index (CPI). Measures the average change in the prices of a fixed list of goods and services purchased by families and individuals in urban areas across the country. Although it is often called the “Cost-of-Living-Index”, it measures only price changes, just one of several factors affecting living costs (OSD).

Current Dollars. Implies adjustment for variation in the purchasing power of a dollar over time. From an economics perspective outside the Department of Defense (DoD), a current dollar is not influenced by outlay rates (expenditure profiles). However, guidelines from OSD (Comptroller) and OMB (see current dollar analysis in OMB Circular A-94) do not distinguish between current dollars and then-year dollars. Therefore, for Air Force financial management activities current dollars are identical to then-year dollars.

DoD Purchase Index. Developed by the OUSD(C) consists of outyear projections based upon fiscal guidance from OMB linked to actual DoD purchase price experience calculated by the Commerce Department’s Bureau of Economic Analysis (BEA) (OSD).

Fiscal Year. The federal government’s fiscal year begins October 1 and ends September 30 which is the time period used by the U.S. Government for all spending budgets.

Fixed-Weighted Price Index. An index that measures the overall price level (compared with a base period) without being influenced by changes in the composition of output or purchases (CBO).

Future Years Defense Program (FYDP). A six year budget plan listing military expenditures.

Gross Domestic Product (GDP). The market value of all goods and services produced during a particular time period by individuals, businesses, and government in the U.S. whether they are U.S. or foreign citizens or American owned or foreign owned firms. It includes income earned by U.S. owned corporations overseas, by U.S. residents working abroad, but excludes income earned in the U.S. by non-U.S. residents.

GDP Implicit Price Deflator. The ratio of GDP in current prices to GDP in constant prices (OSD).

Gross National Product (GNP). The market value of all goods and services produced during a particular time period by U.S. individuals, businesses, and government. It includes income earned by U.S. owned corporations overseas, by U.S. residents working abroad, but excludes income earned in the United States by residents of the rest of the world.

Implicit Deflator. An overall measure of the price level (compared with a base period) given by the ratio of current-dollar purchases to constant-dollar purchases. Changes in an IPD, unlike those in a fixed-weighted price index, reflect changes in the composition of purchases as well as in the prices of goods and services purchased (CBO).

Index. An indicator or summary measure that defines the overall level (compared with a base) of some aggregate--such as the general price level or total quantity-- in terms of the levels of its components (CBO).

Inflation. An increase in the general level of prices in the economy (OSD).

National Defense Budget Estimates for 19xx. Referred to as the *Green Book*, provides the accounting, budgeting, and economic background to the FYDP.

Nominal. Measured in the dollar value or in market terms of the period under consideration (CBO).

Office of Management and Budget (OMB). Evaluates, formulates, and coordinates management procedures and program objectives within and among Federal Departments and agencies. It also controls the administration of the Federal budget while routinely providing the President with recommendations regarding budget proposals and relevant legislative enactment's.

Other Purchases. Defined by Jack (1997) as DoD non-fuel and non-personnel expenditures.

Outlays. Actual expenditures, some of which are covered by amounts that were authorized in previous years.

Outyears. The years after the first year of a budget or analysis.

President's Budget. Proposal sent by the President to Congress each year as required by the Budget and Accounting Act of 1921, as amended.

Price Relative Index. Expresses the percentage change in the price of a single commodity from one time period to another. It is calculated by dividing the price at time period two (T2) by the price at time period one (T1).

Real. Adjusted to remove the effects of inflation with represents volume or quantity rather than dollar value, of goods and services. Real data are usually constructed by dividing the corresponding nominal data, such as output or a wage rate, by a price index or IPD. For example, real interest rate is a nominal interest rate minus the expected inflation rate (CBO).

Then-Year Dollars. Implies adjustment for variation in the purchasing power of a dollar over time. From an economics perspective outside the Department of Defense (DoD), a then-year dollar is influenced by outlay rates (expenditure profiles). However, guidelines from OSD (Comptroller) and OMB (see current dollar analysis in OMB Circular A-94) do not distinguish between then-year and current dollars.

Topline. The total DoD allowance from the OMB referring to total budget authority.

Total Obligation Authority (TOA). The financial requirement of the Future Years Defense Plan, or any component thereof, needed to support the approved program of any fiscal year. Always expressed in then-year or current dollars. A DoD financial term which expresses the value of the direct defense program for a fiscal year.

Unified Federal Budget. The present form of the budget of the federal government in which receipts and outlays from federal funds and trust funds are consolidated into a single total (Collender, 1997).

Yield Curve. The relationship formed by plotting the yields of otherwise comparable fixed-income securities against their terms of maturity. Typically, yields increase as maturities lengthen. The rate of this increase determines the "steepness" or "flatness" of the yield curve. Ordinarily a steepening of the yield curve is taken to suggest that relatively short-term interest rates are expected to be higher in the future than they are now (CBO).

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Vita

Captain Mark S. Sweitzer was born 4 December 1965 at Ramey AFB, Puerto Rico. He graduated in June 1989 from Central Washington University with a Bachelor of Science in Economics where he was a distinguished graduate and earned a regular commission through the Reserve Officer Training Corps. He was first assigned as a Missile Launch Officer at Malmstrom AFB, Montana where he later served as a Flight Leader. He also earned a Master's Degree in Aeronautical Science through Embry-Riddle Aeronautical University in September 1991. In 1993, he transferred to Fairchild AFB, Washington where he served as the Officer in Charge of Training at the 92nd Air Refueling Wing Command Post. While assigned to Fairchild AFB, he completed Squadron Officer School in residence and served a tour in Saudi Arabia during Operation SOUTHERN WATCH. In May 1996, he entered the Graduate School of Logistics and Acquisition Management, Air Force Institute of Technology. Upon completion of the Graduate Cost Analysis program, Captain Sweitzer, his wife, Caryn, and daughter, Linsay Marie will relocate to Los Angeles AFB, California, where Captain Sweitzer will be assigned to the Space and Missile Systems Center.

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AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. **Please return completed questionnaire to: AIR FORCE INSTITUTE OF TECHNOLOGY/LAC, 2950 P STREET, WRIGHT-PATTERSON AFB OH 45433-7765.** Your response is **important**. Thank you.

1. Did this research contribute to a current research project? a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?
a. Yes b. No

3. **Please estimate** what this research would have cost in terms of manpower and dollars if it had been accomplished under contract or if it had been done in-house.

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4. Whether or not you were able to establish an equivalent value for this research (in Question 3), what is your estimate of its significance?

a. Highly b. Significant c. Slightly d. Of No
Significant Significant Significance

5. Comments (Please feel free to use a separate sheet for more detailed answers and include it with this form):

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